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ABSTRACT

These conference proceedings address the capabilities of technology in education. Papers and summaries of presentations are provided on topics such as: grants for educational technologies; telecomputing and electronic mail projects; instructional software and hypermedia design projects; curriculum integration; local control of the Internet; captioning for the hearing impaired; multilingual courseware and word-processing; intellectual property issues in a networked environment; multimedia use in various subject areas and in student assessment; technology's impact on teacher preparation and education; MicroWorlds; computer simulations; computer abuses and ethics; Electronic Performance Support Systems; the Star School program; problem solving for computer courses; restructuring; electronic classrooms and distance learning; partnerships in education; lifelong learning communities; interactive video and tutorials; object-oriented programming; collaborative teaching and learning; technology and intergenerational activities; and technology and educational equity. Committee members and session presiders are listed, and member societies are highlighted. The proceedings also include an alphabetical listing of authors, keywords, and session codes. (BEW)

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ED 396 665

Conference Proceedings

National Educational Computing Conference

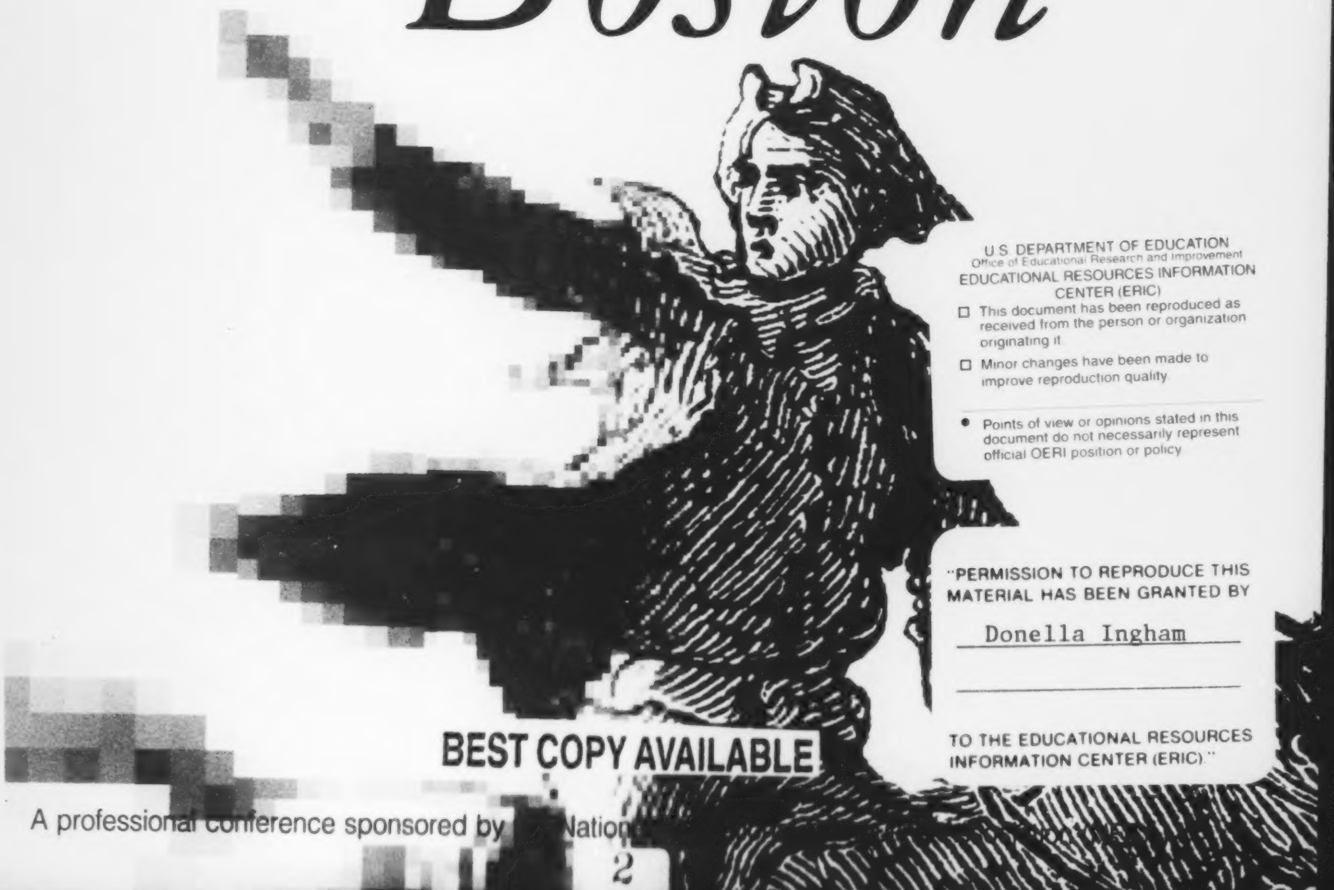
Boston, Massachusetts

June 13-15, 1994

Hosted by:
Lesley College
Bolt Beranek and Newman
Chapter 1 Computer Cooperative Center
EDCO Collaborative
Education Development Center, Inc.
Massachusetts Computer Using Educators
Massachusetts Corporation for Educational Telecommunications
Massachusetts Department of Education
The Boston Computer Society

Recreating the Revolution

NECC '94 *Boston*



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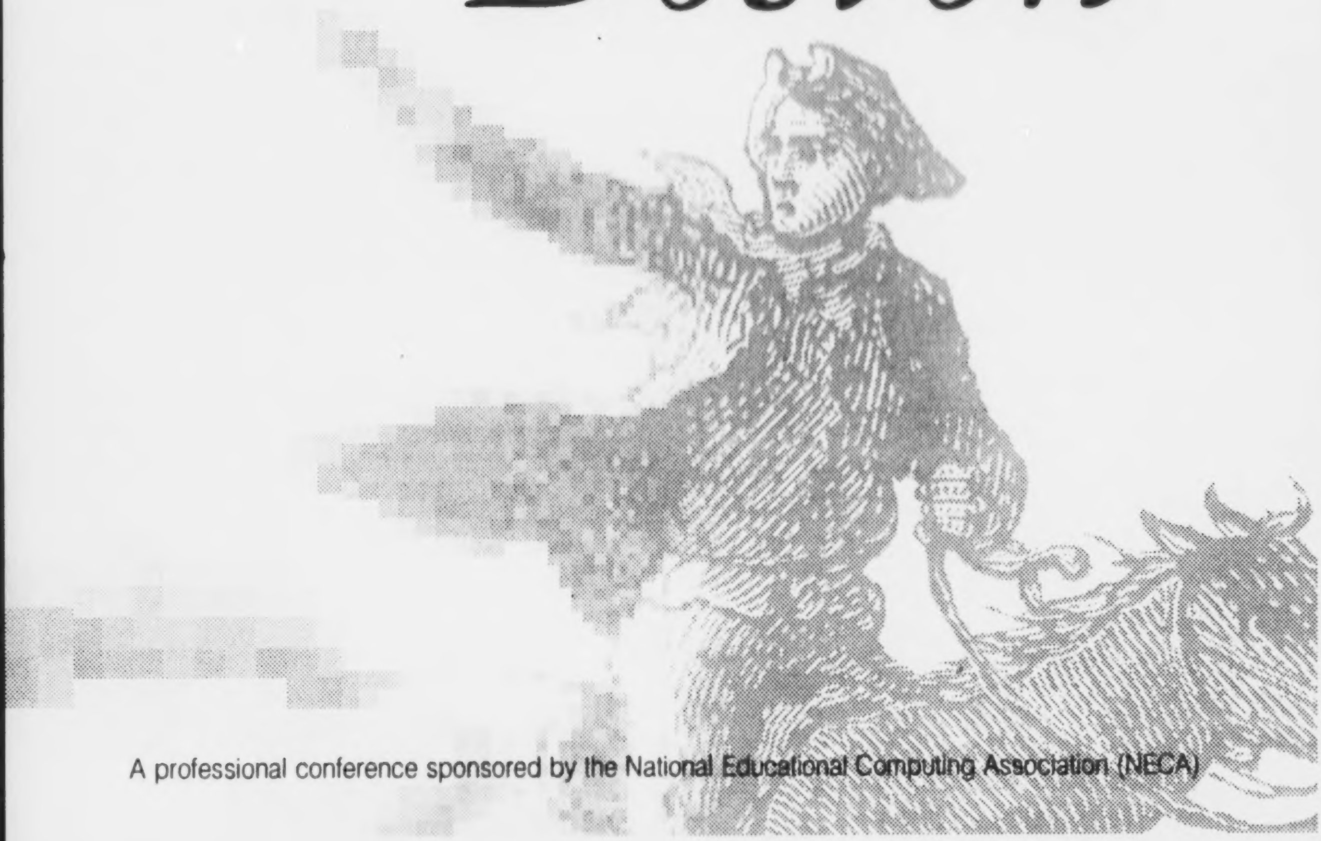

A professional conference sponsored by the National Educational Computing Association (NECA)

Proceedings of NECC '94

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You are invited to share in *Recreating the Revolution!*

This is a time of change—break-the-mold schools, charter schools, restructuring, systemic reform. The fifteenth annual National Educational Computing Conference, NECC '94, will focus on the proper role of technology in this revolution. Recreating the Revolution is the conference theme.

Keynote speakers will address this distributed revolution. See and hear from different perspectives on connecting technological activities to the reform efforts. Beginning with reform, **Philip Schlechty** will speak about school reform, and the new rules, culture, and commitment that are required. The U. S. Assistant Secretary of Education, **Sharon Porter Robinson**, will speak about the renaissance of the reform movement and the role of the teacher. As co-director of the National Education Association's National Center for Innovation, she has helped lead the NEA reform efforts. **Linda Roberts**, Special Advisor on Educational Technology for the U. S. Department of Education, has brought together an industry panel to address the potential of the national information superhighway for schools and learning. And perhaps most importantly, this revolution begins and ends with teachers. **Tom Snyder**, of Tom Snyder Productions, will speak about the role of the teacher in this technology revolution. In keeping with our theme, we are introducing a new strand in the conference, Revolutionary Classrooms, featuring teachers experimenting with new classroom structures and new technologies.

Many people have dedicated a revolutionary number of hours to making this conference an outstanding one: the Local Committee, subcommittees, and their supporting organizations; the NECA Board and Committee; the NECC staff at ISTE; President Margaret McKenna and the administrators, faculty, and staff members of Lesley College; President George Conrades, and members of the Educational Technologies department of Bolt, Beranek, and Newman; and Paul Katz and his very competent staff at the University of Oregon Division of Continuing Education.

Special recognition and appreciation is given to the many individuals who gave of their time and talents to work as converence volunteers. Thanks to each of the presenters, presiders, session leaders, and workhops leaders who contributed to creating a fantastic conference program.

June is a wonderful time to experience Boston. Thank you for joining us so we can work together, *Recreating the Revolution*.

Welcome!

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John Richards—Bolt Beranek and Newman

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1993-1994 NECA Member Societies

The following descriptions are provided for the professional societies/associations that belong to the National Educational Computing Association (NECA). Contact information for each society is given following the society's description.

AAHE—American Association for Higher Education

AAHE is a membership association of individuals interested in improving the effectiveness of the higher education enterprise as a whole and their own effectiveness in their particular setting. The Association's membership includes more than 8,000 administrators, faculty, and students from all sectors, as well as policy makers and leaders from foundations, business, and government.

AAHE is higher education's "citizen's organization," where individuals step beyond their special roles to address collectively the challenges higher education faces. Members share two convictions: that higher education should play a more central role in national life, and that each of our institutions can be more efffective. AAHE helps members translate these convictions into action.

Through conferences, publications, and special-interest projects, members acquire both the "big picture" and the practical tools needed to increase their effectiveness in their own setting, and to improve the enterprise as a whole.

Contact: Louis Albert, AAHE, 1 Dupont Circle, Suite 360, Washington, DC 20036-1110.

SIGCAS—ACM Special Interest Group on Computers and Society

SIGCAS is the Association for Computing Machinery's Special Interest Group on Computers and Society. With a membership of nearly 1,200, this professional group seeks to identify social issues raised by computer technology and to provide a forum for discussion on how to approach these issues.

SIGCAS publishes a quarterly newsletter, *Computers and Society*, which is a primary source of material on this topic. As a vehicle of communication for the SIGCAS membership, it includes news, comments, and articles on any societal issues raised by computing technology. One of the few periodicals on this subject, it provides a flexible and timely forum for important, evolving topics, such as data quality, employment, and intellectual property rights.

According to a recent membership survey, about 40% of SIGCAS members teach course material on computers and society. In recent years SIGCAS has organized sessions at computer conferences on topics such as computer ethics and organizational impacts of computers.

Contact: C. Dianne Martin, EECS Department, George Washington University, 6th Floor, Academic Center, Washington, DC, 20052, diannem@seas.gwu.edu.

SIGCSE—ACM Special Interest Group on Computer Science Education

SIGCSE became a special interest group of ACM in 1970. It currently consists of over 2000 members from the educational, industrial, and governmental communities interested in various aspects of computer science education. SIGCSE has goals of encouraging and assisting in the development of effective academic programs and courses in computer science and promoting research in computer science education.

The following are objectives of SIGCSE:

1. To provide a continuing forum for discussion of common problems among education and other computer scientists through organized meetings and symposia.
2. To publish a bulletin at least quarterly containing information aimed specifically at those interested in computer science education.
3. To work closely with the Education Board of ACM to insure implementation of effective education programs by the Association.

Contact: Harriet Taylor, Computer Science Department, Louisiana State University, Baton Rouge, LA 70803-4020, taylor@bit.csc.lsu.edu.

SIGCUE—ACM Special Interest Group on Computer Uses in Education

SIGCUE provides a forum for the discussion of ideas, methods, and policies related to all aspects of computers in the educational process. Established in 1969 its membership (over 1,400 persons) comes from many countries and numerous, diverse institutions and businesses.

SIGCUE publishes a newsletter titled the SIGCUE *Outlook*. Recent topics have included Preservice Education in Educational Computing, International Reports on Educational Computing, and a Teacher Training Curriculum Project. SIGCUE also sponsors and organizes technical sessions at ACM annual meetings, the National Educational Computing Conference, and other national and regional meetings of interest to its members.

Among SIGCUE's goals are (1) helping to bring the technical expertise within ACM to bear upon educational compting generally, (2) cooperating with other special interest groups or educational societies to promote attention to educational computing issues, and (3) providing written and verbal forums for members and the educational community to exchange ideas concerning computer uses in education.

Contact: John Lawson, Special Education & Transition Programs, University of Oregon, College of Education, Room 175, Eugene, OR 97403-1211, john_lawson@ccmail.uoregon.edu.

SIGUCCS—ACM Special Interest Group on University and College Computing Services

SIGUCCS provides a forum for those involved in providing computing services on a college or university campus. The topics addressed by SIGUCCS include managing campus computing, computing as it relates to the overall goals of the institution, and the state-of-the-art in various types of college and university computing services, and provides opportunities to discuss and share ideas and experiences with others.

Two annual conferences are regular activities of SIGUCCS. The Computing Center Management Symposium addresses the many aspects of managing computing on campus. This includes hardware, software, planning, finances, and personnel, to name few. The User Services Conference deals more directly with the delivery of particular services to the higher education community. Tutorials on relevant issues are held at both conferences.

In other projects, SIGUCCS offers a Peer Review of the university computing function. Upon request of the computer center director, members of SIGUCCS will formally analyze and comment on different areas of the campus computing function. SIGUCCS also publishes a quarterly newsletter. We consider the newsletter our most important form of communication as it reaches all members and is subscribed to by numerous university computing centers. Conference proceedings are published either as separate documents or as part of the newsletter itself.

Contact: Jim Kerlin, 229 Computer Building, Center for Academic Computing, Pennsylvania State University, University Park, PA 16802, jnk@psuvm.psu.edu.

AECT—The Association for Educational Communications and Technology

The Association for Educational Communications and Technology (AECT) is an international professional association dedicated to the improvement of instruction at all levels through the appropate use of instructional technology. Founded in 1923, AECT has eveloved as an organization as the technology used in education has eveloved, from the early use of traditional audiovisual media to today's interactive and multimedia technology platforms. AECT members can be found at all levels of public and private education, from elementary schools to colleges and universities, as well as in the corporate and government sectors.

Organizationally, AECT has nine special interest devisions, eight chapters, forty-six state affiliate organizations, and fourteen national and international affiliate organizations. With over 5000 members, AECT is the largest international association for professionals involved in the integration of instructional technology to the learing process. AECT is the United States representative to the International Council for Educational Media.

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Tech Trends, in its 37th year of publication, is the Association's professional periodical. Published during the school year, *Tech Trends* features authoritative, practical articles about technology and its integration into the learning environment. *Educational Technology Research and Development*, the Association's research quarterly in its 40th year of publication, is the only refereed journal focusing entirely on research and instructional development in the rapidly changing field of educational technology.

AECT also publishes reference books on a variety of topics, including practical applications of technology, research, copyright, and standards and guidelines for the field of special interest to insructional technologists.

The AECT national convention and exposition is held each year in January or February, drawing over 12,000 participants and exhibitors. Additionally, AECT sponsors an annual professional development seminar focusing on emerging technologies and a leadership development conference for leaders within AECT and its affiliates.

Contact: Stanley Zenor, AECT, 1025 Vermont Avenue, NW, Suite 820, Washington, DC 20005, 202/347-7834.

CCSC-Consortium for Computing in Small Colleges

CCSC is a not-for-profit organization focused on promoting effective use of computing in smaller institutions of higher education which are typically non-research in orientation. It supports activities which assist faculty in such institutions to make appropriate judgments concerning computing resources and educational applications of computer technology.

Because departments in smaller colleges and universities are usually small and not highly specialized, the Consortium encourages the sharing of expertise, effective curriculum patterns, and efficient technological applications. The Consortium is concerned with the advancement of major programs in both computer science and computer information systems, and with the use of computers in the liberal arts and sciences.

The Journal of Computing in Small Colleges is distributed to faculty in more than 200 colleges across the country. Now in its sixth volume, its five annual issues are averaging 500 pages with articles addressing the broad spectrum of curriculum and computer use in higher education.

Contact: Gail Miles, Lenoir-Rhyne College, Box 7482, Hickory, NC 28603, miles@alice.lrc.edu.

ECMI—Educational Computing in Minority Institutions

ECMI is an organization run by a steering committee representing institutions whose student body reflects a large identifiable minority population. The objectives of ECMI are:

1. Computer literary: To create among the faculty and administrators of the minority institutions an awareness and understanding of the strengths and weaknesses, uses and issues, advantages and disadvantages, feasibility, practicability and limitations of computer applications in all aspects of society, including education.
2. Educational Computing: To narrow the gap which exists between the faculties in minority and non-minority institutions with respect to educational computing know-how and access.
3. Research Computing: To improve the computing facilities available to faculty of minority institutions for research purposes, particularly in those institutions offering graduate programs.
4. Technical assistance—consultants: To provide expert and impartial technical assistance to academic administrators of minority institutions on all phases of academic computing (Instruction and research).
5. Education programs in the computer sciences: To improve the offerings of courses and degree programs in the computer sciences at minority institutions at all levels (e.g., introductory courses, minors, 2-year degree programs, 4-year degree programs, continuing education, graduate programs).
6. Computing facilities: To improve both quality and quantity of computing facilities available in minority institutions, because experience in the non-minority institutions has shown that an adequately staffed and equipped computer center for academic computing is essential to the success of previously stated objectives.
7. Direct student assistance: To increase the availability of minority staff for the computer centers and computer science education programs of minority institutions.
8. The need for a comprehensive program: To facilitate coordination and equitable distribution of funded activities to qualified institutions, associations, etc.

Contact: Jesse Lewis, Academic Affairs, Norfolk State University, Norfolk, VA 23504, j_lewis@vger.nsu.edu.

EDUCOM

EDUCOM is a nonprofit consortium of colleges, universities, and other organizations serving higher education. Founded in 1964, EDUCOM functions as an association dedicated to the transformation of higher education through the application of information technologies. Through direct services and cooperative efforts, EDUCOM assists its members and provides leadership for addressing critical issues about the role of information technology in higher education.

EDUCOM is committed to the fulfillment of the potential of information technology to realize education that is active and learner centered; free from traditional constraints of time and space; lifelong and collaborative; cost-effective; responsive, dynamic, and relevant; accessible; and outcomes oriented. EDUCOM has historically supported educational networking through computer and communications technology. It has, for nearly a decade, served as the contractor for the operation of BITNET. EDUCOM is committed to shaping the National Information Infrastructure and its uses to enable its effective use by higher education.

EDUCOM is completely self-supporting. Funds are generated from membership dues, conferences, publications, consultations, philanthropy, and collaborations with the National Science Foundation and other government agencies.

EDUCOM's membership includes virtually every major research university in the country: four-year private and public institutions, along with a number of two-year colleges, overseas campuses, foundations, consortia, and research laboratories. Approximately 600 higher education institutions and 110 corporations participate in EDUCOM. Each institutional member appoints a voting representative, who serves as the link between EDUCOM and his or her institution.

The annual conference serves as a forum for sharing concepts, developments, and ideas amongst our community. EDUCOM Review is recognized as the premier source of information on information technology policy and its impact on higher education. EDUCOM also publishes electronic newsletters for the higher education community.

Contact: Carol Twigg, EDUCOM, 1112 16th Street, NW, Suite 600, Washington, DC 20036, inquiry@educom.edu.

IEEE—The IEEE Computer Society

The Computer Society is the world's largest association of computing professionals, with a total membership of approximately 95,000 computer scientists, computer engineers, and interested professionals. Society membership is open to IEEE members, associate members, and student members and to non-IEEE members who qualify for affiliate membership. An affiliate member is a person who has achieved status in his or her chosen field of specialization and whose interests focus in the computing field.

Every Computer Society member receives *Computer*, a peer-reviewed monthly magazine of general interest to computing professionals which also covers society news and events. Nine specialized magazines and seven journals are also available to society members as optional subscriptions and to nonmembers, libraries, and organizations.

Magazines published by the Computer Society include *IEEE Computer Graphics and Applications, IEEE Micro, IEEE Design and Test, IEEE Software, IEEE Expert, IEEE Annals of the History of Computing, IEEE Multimedia, and IEEE Parallel Distributed Technology.* Research-oriented journals include *IEEE Transactions on Computers, IEEE Transactions on Software Engineering, IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE Transactions on Knowledge and Database Engineering, IEEE Transactions on Parallel Distributed Systems*, and *IEEE Transactions on VLSI systems.* The Computer Society Press publishes nonperiodical literature, including tutorial texts and conference records. The society's catalog contains approximately 900 titles which are available for purchase.

The society sponsors or cosponsors more than 100 conferences and meetings ranging from workshops and symposia with a few dozen participants to major conferences with many thousands of attendees. Over 30 technical committees offer the opportunity to interact with peers in technical specialty areas, receive newsletters, and conduct conferences and tutorials.

The Computer Society has over 100 local chapters throughout the world, and an additional 100-plus student chapters which provide the opportunity to interact with local colleagues and hear experts discuss technical issues. In addition, tutorials, educational activities, accreditation of computer science and engineering academic programs, the development of standards, and an international electronic mail network all play prominent roles in the society's activities.

Contact: Mike Mulder, Center for Advanced Computing Studies, University of Southwestern Louisiana, P.O. Box 44330, Lafayette, LA 70504, mulder@cacs.usl.edu.

ISTE—International Society for Technology in Education

The International Society for Technology in Education, ISTE, is the merged society of the International Council for Computers in Education and the International Association for Computing in Education. ISTE is a non-profit educational organization, with 12,000 individual members and over 60 organization and associate members.

ISTE publishes *The Computing Teacher, Journal of Research on Computing in Education, CÆLL Journal, Microsoft Works in Education, IRM Quarterly*, and books and courseware for persons interested in the instructional use of computers at the precollege level. These publications emphasize teaching about computers, teaching using computers, teacher education, and the impact of computers on curriculum.

ISTE has a substantial and growing professional outreach program. Five major components currently include:

1. Organization Affiliate Members. Members publish newsletters and/or journals, hold conferences, and directly interact with their own members.
2. Professional Staff. ISTE has a professional staff who write, edit, participate in conferences, process orders, consult by phone or mail, etc. *The Computing Teacher* is put together by a full in-house production staff.
3. Ad Hoc Committees. Such a committee created the "ICCE Policy Statement on Software Copyright" and "Code of Ethical Conduct for Computer Using Teachers."
4. Special Interest Groups. ISTE has organized special interest groups for computer coordinators, teachers of educators, computer science educators, Logo-using educators, telecommunications, and hypermedia/multimedia.
5. Independent Study courses. ISTE offers eleven independent study courses carrying graduate credit from the Oregon State System of Higher Education.
6. Private Sector Council. The Council represents a broad range of corporations and services in an advisory capacity to ISTE's Board of Directors.

Contact: ISTE, 1787 Agate Street, Eugene, OR 97403-1923, ISTE@oregon.uoregon.edu.

ISTE SIGTC—The Special Interest Group for Technology Coordinators

The Special Interest Group for Technology Coordinators (SIGTC) is a professional organization that helps technology coordinators meet the challenges of a rapidly changing field. We provide an excellent forum to identify problems and solutions, and share information on issues facing technology coordinators at the precollege level.

SIGTC publishes *SIGTC Connections*, a quarterly publication, through the International Society for Technology in Education (ISTE). Articles in *SIGTC Connections* contains helpful information and answers to questions such as:

- Who's doing what to organize and communicate with teachers and administrators?
- What committees and techniques work best for other coordinators?
- How can technology coordinators enlist the support of school site administrators?

Contact: Bonnie Marks, Alameda County Coffice of Education, 313 W. Winton, Hayward, CA 94544, bmarks@ctp.org.

ISTE SIGTE—The Special Interest Group for Teacher Educators

SIGTE is the ISTE Special Interest Group for Teacher Educators involved in educational technology. SIGTE provides a forum for members to share successes, raise questions, and meet the challenges of helping other professionals use technology to enhance learning and education. It publishes a quarterly journal, the *Journal of Computing in Teacher Education*, that works to provide its members with the answers to practical, leadership, research, and theoretical questions such as:

- What is happening in K-12 computer education that relates to teacher education programs?

- What funding issues are in the fore front of current preservice and inservice teaching areas
- What are the directions in teacher education as raelated to computer and technology education?
- How can educators become effective critics and implementers of innovations using technology?

Contact: M.G. (Peggy) Kelly, College of Education, California State University—San Marcos, San Marcos, CA 92096-0001, mkelly@ctp.org.

SCS—The Society for Computer Simulation

The Society For Computer Simulation (SCS) is the only technical society devoted primarily to the advancement of simulation and allied technology. It has a worldwide membership and a network of regional councils that covers the United States, Canada, the United Kingdom, Europe, and the Pacific Rim.

Simulation is used in every scientific and technical discipline including aerospace, biomedical, business, education, engineering, and manufacturing. Areas that have been specifically recognized as important to SCS members include artificial intelligence, CAD/CAM, education, environmental issues, knowledge based systems, robotics, simulators, and standards.

The society publishes *Transactions of SCS* (an archival journal) quarterly and *SIMULATION* (a journal of applications of simulation) monthly.

Besides the flagship Summer Computer Simulation Conference, (SCSC) the society sponsers several other conferences including the SCS Western Multiconference, the SCS Eastern Multiconference, the Winter Simulation Conference, and the European Simulation Symposium..

Contact: Charles Shub, University of Colorado—Colorado Springs, Computer Science Department, Colorado Springs, CO 80933, cdash@cs.colorado.edu.

CAUSE

CAUSE is the association for managing and using information technology in higher education, with a focus on enhancing the administration and delivery of higher education through the effective management and use of information technology. Through its programs and services, CAUSE serves over 3,050 members on more than 1,100 college and university campuses around the world.

CAUSE member services include:

- Professional Development-through the annual conference, seminars, the CAUSE Management Institute, workshops, constitutent groups, and recognition programs, including the CAUSE ELITE (Exemplary Leadership and Information Technology Excellence) Award and the CAUSE Award for Excellence in Campus Networking.
- Publications-including the quarterly CAUSE/EFFECT magazine, several newsletters, the CAUSE Professional Paper Series, and other member publications.
- Information Exchange-through the Exchange Library with more than 2,500 items, including documents contributed by member campuses, CAUSE/EFFECT articles, conference papers, and videos, and the CAUSE Institution Database (ID) Service, a custom reporting service with data about computing environments on CAUSE member campuses.

Contact: Michael Zastrocky, CAUSE, 4840 Pearl East Circle, Suite 302E, Boulder, CO 80301, (303)449-4430, ZAS@CAUSE.Colorado.edu

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Conference Sessions

Monday, June 13, 1994

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Special Session (M1-BRCA)

A Symposium on Grants and Contracts in Educational Technologies: Federal Perspective

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Key words: research, telecommunications, funding, criteria, government agencies

Abstract

The main objective of this symposium is to inform researchers and practitioners about the possible sources of funding in the area of educational and telecommunications technologies. More specifically, it will focus on the priorities for research funding in various Federal Departments/agencies. In addition, this symposium will highlight the criteria that are used by Federal agencies to select the "winners" in the funding competitions.

Gary Johnson and Frederick Howes, U.S. Department of Energy

The Office of Scientific Computing (OBC) is responsible for the Department of Energy (DOE) component of the Federal High Performance Computing and Communications (HPCC) Program. Part of the HPCC program invinvolves education. If computational science and engineering are to play an important role in our economy, we need to insure that our workforce is equipped with the education necessary to use these new approaches to creating goods and services. Thus, OSC supports a wide range of educational programs, ranging from K-12 through graduate school. The focus of our K-12 programs is on the appropriate use of educational technologies to support educational objectives and systemic reform. This presentation will discuss the rationale for our program, review currently funded projects and present out plans for future activities.

Malcom Phelps, National Aeronautics and Space Administration (NASA)

NASA's Educational Technology Program is designed to ensure that the knowledge, data and technologies derived from the Agency are used to achieve excellence in education. NASA has established the following four (4) objectives for its educational technology program and supports projects in the areas of research, technology translation, dissemination, curriculum materials.

Nora Sabelli, National Science Foundation

This presentation will discuss the new strategic and coordinated approaches that several National Science Foundation (NSF) programs are developing in the area of technology applications in support of educational innovation. Case studies will be used to highlight how these strategies can be implemented and the criteria used to review projects. The audience will help the presenters discuss how to measure the impact of NSF projects and of the overall strategy.

Ram Singh,U.S. Department of Education

This presentation will discuss the funding of technology-based research projects by the Office of Educational Research and Improvement (OERI) over the past few years. This presentation will highlight research projects funded under such OERI programs as the Eisenhower research projects funded under such OERI programs as the Eisenhower Science, mathematics, and technology program, funds for innovations in education program; R & D Centers program; Field-Initiated Studies program; SBIR program; and Star Schools program. In addition, it will focus on the criteria that are used for selecting the "winners" in those competitions.

Society Session (M1-201A)

SIG/Tel Exemplary Telecomputing Projects

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Key words: online, projects, contest, classroom

Abstract

SIG/Tel, the ISTE special interest group for telecommunications, anually sponsors an online, international contest to find exemplary classroom electronic projects and activities. Winning projects come from around the world, from traditional and non-traditional classrooms, and from elementary through university classrooms. At this session, the 1994 winners will receive their prizes and will showcase their winning projects. Prizes are subscriptions to online services which include America Online, Compuserve, Dialog, Iris, Learning Link, Prodigy, Scholastic, and World Classroom. Attendees will have an opportunity to meet the project presenters, representatives of the online services, and SIG/Tel members.

Special Session (M1-202A)

Kids Create Kids' Software: An Instructional Software Design Project

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Key words: LogoWriter, programming, cooperative learning, integrated curriculum, business-education partnerships

Abstract

From October to June during the 1992-1993 school year, 29 fourth graders in a Bellevue public school formed seven computer companies and learned about programming and cooperative learning while developing instructional software, in LogoWriter, for second and third-graders. Each company was modeled after a real software company and consisted of a developer or programmer, designer, documentor, and project leader. Students taught each other programming skills. At key points in the project, employees of local computer or computer related businesses (Microsoft, Compu-Teach, Edmark, Software Productions Inc.) interacted with the students sharing their various expertise. The student companies had the freedom to choose an area of specialization within the science or math curriculum which they used as their focus in creating instructional software. Topics from space to dissecting slugs were developed into completed products replete with documentation. These products were then boxed, shrinkwrapped, and sold at the school's science fair. Approximately 700 copies of the student software were sold at $1.00 apiece. Proceeds will go towards purchasing a new computer for this classroom. Inspiration for the work was drawn form Idit Harel in her book *Children Designers: Interdisciplinary Constructions for Learning and Knowing Mathematics in a Computer-Rich School.*

References

Harel, Idit. (1991). Children Designers: Interdisciplinary Constructions for Learning and Knowing Mathematics in a Computer-Rich School. Norwood, NJ: Ablex Publishing Corporation.

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Special Session (M1-203A)

Infusing Kidlink Telecommunication Activities into a Middle School Curriculum

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Key words: middle school, telecommunications, interdisciplinary, age 10 to age 15

Abstract

Kidlink is one of several listserv lists begun by a writer in Norway and housed on computers in South Dakota. It is designed for students ages 10 to 15, which include fifth to ninth graders in the United States educational system. All students begin their association with Kidlink lists by answering 4 questions:

1. Who am I?
2. What do I want to be when I grow up?
3. How do I want the world to be a better when I grow up?
4. What can I do now to make this happen?

Students can write electronic pen pals using the Kidcafe list, where the metaphor of a "cafe" describes how students meet, greet and learn about each other. The Kidforum list is used for classes who agree to participate in one of the myriad of telecommunications projects.

Projects are often interdisciplinary, always attract classes from a variety of countries and engage students on several cognitive levels. Each panel member is a veteran teacher with experience of successful integration of these telecommunication activities into their area of speciality. In addition, we will discuss helpful hints for smoothly incorporating telecommunications into the curriculum.

Virginia

At Northcross School in Roanoke, sixth grade students, ages 11-12 sent responses to the Kidlink questions to the international discussion group, response@vm1.nodak.edu. Once students had introduced themselves, they were ready to plan a three-day vacation tour of Roanoke for other participants in the **Virtual Vacation**, a project run on kidforum@vm1.nodak.edu.

The middle school wall outside the computer lab displayed samples of vacations from other places. Messages came from students in Russia, Slovenia, Uruguay, England, Finland, Denmark, and Iceland. The sixth graders learned that Portoroz is a tourist city by the sea in Slovenia. Students in Finland suggested barbecued sausages for lunch while students from Iceland recommend singed head of lamb.

In addition, students from 11 states have written travel logs for their cities. Our students wrote their vacation plans for our city in groups of four. They used an electronic Atlas and MacGlobe to research local points of interest. Their itineraries included game arcades, local restaurants, malls, movie theaters, museums, and historic places. It was a rewarding experience to consider the activities a visitor to Roanoke could enjoy as well as "visiting" other places around the world—without leaving home!

New Jersey

At Immaculate Conception School in Somerville, the students and teachers are using the Kidlink projects to expand their textbooks, facilitate more student-centered learning and to extend cross-curricular links from grade to grade and from subject to subject.

This winter classes participated in the **Sports and Olympics Sports** project, which began before the winter Olympics. This project engaged students in a variety of activities, such as researching and sending answers to the Olympics Quizzes written by an educator in Norway, creating *HyperCard* Olympic Event Cartoons, and taking a field trip to see a special "Sports" exhibit from Canada .

Arctic Exploration, through Kidforum@vm1.nodak.edu., is an ongoing shared experience for many students. The project began with an Internet Relay Chat (IRC), a real time "chat" system where messages typed from all participant computers are replicated on the screens of every person logged on. The IRC included the moderator from England, people in Slovenia and Australia as well as many places in the US. Simultaneously, a videoconference beamed images of the three intrepid explorers who were in England. Students were able to use the IRC to relay questions to a teacher participating in the videoconference.

The school has joined other projects posted on Kidleadr@vm1.nodak.edu such as **Bird Migration** studies from many different areas of the United States, an ongoing **Space Simulation Experiment** project and other regional activities from around the world.

Kidlink has connected the teachers and students with our global neighbors, and has reduced significantly the misconceptions about people in far away lands. In addition, it has made our curriculum much more relevant to each student's needs and requests, removing any arbitrary boundaries between subjects, and widening our source of knowledge and understanding of lifestyles and people all over the world.

South Carolina

At Castle Heights Middle School in Rock Hill students communicate with others around the world for both curriculum projects and personal discovery. Students have received messages from Lithuania, Estonia, Hawaii, Alaska, and many other places both inside and outside the United States.

Every May, students participate in the **Big Days**, a celebration planned for Kidlink participants communicating through ham radio, fax, videophone, E-mail and the IRC. In addition to the chat, another highlight of the celebration were videophone conversations with students in Charleston, SC and Maui, Hawaii. Celebration activities created much interest in map reading, time zones, and seasons. Students were amazed to discover how similar and yet how different life is for students in various parts of the world.

Sixth grade computer students enjoyed participating in the **Festivals** project. Students wrote about their favorite holidays and festivals including Yap Ye Iswa on the Catawba Indian reservation and Rock Hill's annual Come See Me festival. American youths particularly enjoyed learning about the thirteen Icelandic Santa Clauses and their functions.

In January, 1993, students exchanged greetings and messages with their Kidlink friends concerning the **Inauguration of President Clinton**. First, students in the after-school intramural program sent greetings to students in the American School in Frankfurt, Germany, for their inaugural celebration. Then all computer students shared their hopes for the world under the new administration with students in Denmark.

The first week of February, 1993, brought a special treat to students. A computer teacher from Lima, Peru, whose students participate in Kidlink, visited our classes. Although the main purpose of her school-sponsored trip was to gather ideas for improving teaching techniques in her school, there was still time for students to ask questions about life and youth activities in Peru.

Through these telecommunications projects, students have learned about differences in cultures and in languages. They have developed friendships that transcend continental boundaries, age limits, and political ideals. They have also expanded their geographical knowledge. Even more importantly, they have learned to accept differences in people and their cultures.

The future depends on the ability of the leaders of tomorrow to really communicate with each other. Kidlink offers our students a great opportunity to begin this process now.

Society Session (M1-204A)

An Introduction to Parallel Computing—A Tutorial

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Key words: parallel processing, parallel algorithms, parallel architectures, teaching parallel processing

Abstract

This tutorial is intended to introduce faculty at all levels to parallel processing concepts, parallel computer architectures, and parallel algorithms. The various computational models used in parallel computing will be presented. Examples of algorithms will be presented for each of the computational models. Participants will also be given example programming exercises that can be used with students for each of the computational models. Participants will be given information about obtaining public domain materials for teaching parallel computing, about existing textbooks, and about sites which provide parallel computer access to institutions having no parallel hardware.

Special Session (M1-206A)

Taking Local Control of the Internet in Schools and Districts

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Key words: Internet, K-12, online publications, networking, client-server, MUSE, gopher

Abstract

A rapidly growing number of K-12 schools and districts are becoming their own Internet domains. Instead of accessing only remote Internet resources or logging into remote hosts for E-mail and bulletin boards, these schools and districts are putting their own resources up on the Internet for both local consumption and access by students and educators around the international Internet. Schools and districts are creating databases of lesson plans, creating student newswires, setting up project bulletin boards, and hosting virtual communities on their own servers. While such schools and districts number in the low 100's at this point, the numbers of new K-12 domains is accelerating and is expected to be in the 1000s by NECC '95. Educators from schools and districts that are operating their own Internet servers as part of the NSF-funded National School Network Testbed come together in the panel to share their experiences.

Paul Reese describes the publication channels that open up for elementary students as their newspaper and other products are made available on a "gopher" server for both the school and the wider Internet community.

Richard Fabian describes his district's approach to setting up a district-wide networking using client-server technology to support both instructional and administrative goals.

Toby Caplin describes the construction of a MUSE (multi user simulation environment) as a collaborative enterprise among middle school student that drew in mentors from around the Internet.

Denis Newman outlines the Testbed goals and introduces the infrastructure issues that the project is addressing

These are pioneers in constructing educational value with this technology. They bring a unique perspective on the Internet, showing how schools and school districts can be constructors of, not just consumers on the information superhighway.

Revolutionary Classroom (M1-207A)

America, America: A Thematic Unit that Integrates Technology

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Key words: curriculum integration, 4-Mat, CD-ROM, videodiscs, instructional materials, parent involvement, citizenship

Abstract

The classrooms of tomorrow will have to address the unique learning styles of every student. Education cannot be mass produced. It must be tailored to fit the needs of every child.

The educator can attempt to address these needs through awareness of learning styles and thought processes. Individual differences are then addressed in the planning, instructional and assessment stages.

The thematic unit, "America, America": teaches the basic concepts of being an American citizen; investigates immigration; shares American tall tales; and relates the need for teamwork and cooperation as an American citizen through a study of the American pastime of baseball.

In this unit the Army National Guard is a vital component of parental involvement. Guard visits in the classroom and a field trip to the National Guard Armory in St. Augustine enrich the students in their knowledge of national defense and patriotism. Parent bookmaking celebrations attempt to educate the parents of activities that are relevant for doing at home to assist their children in their educations.

In "America, America" technology is integrated through the use of CD-ROMs, videodiscs, and computers. Instructional materials, such as books, puzzles and games, have been computer-generated. Classroom management materials, to include portfolio design and center management, have been generated by computers.

The Instructional Plan

The educator must consider the learning styles, right/left hemispheric preferences for thought processes, and student modalities in preparing the instructional plan. Basic learning modalities of the class are established through the use of Walter Barbe's Learning Modality Kit published by Zaner-Bloser, Inc. This is a simple assessment technique to help the educator better understand each student.

Learning styles, modalities, and thought processes are addressed through the use of the 4-MAT System Model. Author, Bernice McCarthy, states that "4-MAT is an open-ended teaching method. It is designed to raise teacher awareness as to why some things work with some learners and others things do not. It is adaptable to the developmental level of the students, the content being taught, and the artistry of the moment." Utilizing the 4-Mation lesson developer software by Excel, Inc. assures the educator that all students and most of their learning style needs are being considered.

It's important that the educator consider the cultural backgrounds of every student. With this consideration, one must also remember that the teaching of American ideals is an important part of establishing community and team spirit within our great nation.The thematic unit, "America, America" teaches: the basic concepts of being an American citizen; the history of immigration to America and the questioning of why people come to America; American tall tales; and relates the need for teamwork and cooperation as an American citizen through a study of the American pastime of baseball.

Involving the Parent

Parent involvement is a present concern in education. Parents are concerned about the successes of their children. Parents need to be aware of what is being taught in school and how they can assist their children. Community experts need to be utilized as resources in the classroom and this can be done through parent involvement.

In this particular unit, the Army National Guard was a vital component. A father in the guard visited the classroom early in the unit to teach the Pledge of Allegiance and to explain our nation's flag. All students received Guard t-shirts and booklets on flags. As a culmination activity, the class (dressed in guard t-shirts) visited the National Guard Armory in St. Augustine to learn about: national defense; the need for teamwork in the military; and military transportation and communication.

Parent bookmaking celebrations were attempts to educate the parents of activities that were relevant for doing at home to assist their children. The theme of American tall tales was carried over into this Tuesday afterschool activity with parent and child. Computer-generated text and other needed materials were made available to the participants so that at least one take-home book could be completed each week. some students completed a full set of six books at the end of the unit.

Integrating Technology

The consideration of the integration of technology is very important as we begin to enter the twenty first century. Technology use will be a part of everyone's lives in almost everything we do. Efforts are made to integrate technology through the use of CD-ROMs, videodiscs, and computers.

Students view videodiscs as fantasy ("The American Tale") and reality ("Statue of Liberty") to explore symbols of America. The students learn about tall tale heroes through the use of videotapes and videodiscs. The CD-ROMs "Heather Hits a Home Run" by DISCIS, "The Presidents" by National Geographic and Compton's Multimedia Encyclopedia are utilized to learn about baseball and American symbols.

Instructional materials, such as big books, puzzles and games, have been computer-generated. Pagemaker and MacDraw are the software favorites for this area of development. Classroom management materials, to include portfolio design and center management, have also been generated by computers.

Students use the word processing program, the "Muppet Word Book" by Sunburst, to complete an American flag project where five and six years old children type about the colors that make up our flag and then practice visual motor skills by painting the flag with watercolors. "Kid Pix" by Broderbund is open-ended in creativity; students create word processing documents with color graphics. Audio can also be added to this program. The program seems appropriate and is fun for all users at any level of expertise.

Through the entire unit, students memorize choral readings and songs about America. As a conclusion to the unit, the students create props and costumes to illustrate the memory work. The completed performance is presented and videotaped for future reference.

Conclusion

All students are unique and we must strive to make our instructional programs unique in that the needs of all students will be met. "America, America" is an enhanced unit that strives to meet these needs through an instructional plan, thematic support materials and creative teaching with students actively involved in the learning process.

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Revolutionary Classroom (M1-207B)

To Africa, With Technology

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Key words: curriculum integration, technology, videodiscs, computer-generated materials, multicultural, learning styles, whole language

Abstract

Getting children ready to be productive, competent citizens for the twenty-first century is the job of teachers today. There are many elements to be considered when planning for the educational environment these students will need. Technology use and integration throughout all subject areas is a must. Children must learn how to use these wonderful tools effectively to further their learning. Our knowledge base will expand, but the processes to gain that knowledge will not change. Further, there are some areas that technology can teach more effectively, such as the use of videodiscs and CD-ROM. Our world in the twenty-first century will be more diverse that it is now. We need to make sure that our students understand different cultures and gain the respect for those cultures that will enable them to cooperatively work with a wide range of people. In order for students to learn effectively, teachers must address divergent learning styles in the curriculum. In order to promote better understanding of what is learned, the curriculum needs to taught from a holistic, real word perspective. This thematic unit on Africa encompasses these basic components of twenty-first century instruction.

The Instructional Plan

Children and technology go together. They have a special type of bond. It is imperative that children become familiar with the powerful results to be gained by using many forms of technology. Computers not only enable the child to become empowered by producing products, but can be challenged and involved in learning in new ways. Even very young children can use word processing, paint and draw programs, CD ROM, and videodiscs. Videodiscs enable you to bring an elephant right into the classroom without the mess associated with the live animal. These processes and products will be shared.

Teachers and technology go together. Teachers have less time than ever before and are required to manage more. It is imperative that both children and teachers learn how to be effective managers of time through the use of technology and to competently use new methods of securing information. Teacher made, computer-generated materials will be presented. These cover a wide range of products from big and little books, floor puzzles, meaningful worksheets, games, and Hypermedia. Examples of *HyperCard* and *HyperStudio* stacks will be shared.

What you do not know can be threatening to you. What you know, you are comfortable with. To be able to live in an increasing diverse world, children must know and be comfortable with many cultures or ways of doing things. The culture of Africa is particularly pertinent because it addresses the heritage of many of our students, fostering feelings of pride in being acknowledged and accepted. The people and the environment of Africa provide an enriching experience for all American children.

All children can learn. It is our job as teachers to find the most effective and meaningful methods for that learning to occur. Each one of us has strengths with respect to different intelligences and brain hemispheric dominance affecting learning styles. Using the teachings and materials developed by Bernice McCarthy in the 4-MAT System Model by Excel, Inc., it is possible to plan lessons so that every child has an opportunity to learn in the modality most effective for that student.

Holistic, real world experiences make learning come alive for students. Every part relates to the other parts, making comprehension easier. It is necessary to give learning a framework to facilitate children's understanding. Whole language methods of integration will be discussed.

Parents are a vital part of the educational process and the need for effective parent communication is essential. Technology facilitates this process by giving us the means to do this. Authentic assessment is a must! An exciting video report card method is part of this communication. Children learn to be goal setters and self-esteem is fostered by this powerful feedback. This will be demonstrated along with letters merged with a database and calendars to keep parents informed. Different collaborative assessment tools such as portfolios and classroom management materials will be shared.

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Come and share an incredible journey to Africa by using technology plus a whole lot mere. Be there to see what a classroom can become in the twenty-first century.

Special Session (M1-208A)

School-Based Captioning for the Deaf and Hearing Impaired

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Key words: captioning, deaf, hearing impaired, Macintosh

The Project

During this project presentation, we will discuss and demonstrate the progress on a three-year U.S. Department of Education grant, Access through Captioning: an Improved Captioning System for Programs that Serve Deaf and Hard-of-Hearing Students.

In this project CAST (Center for Applied Special Technology in Peabody, MA) is developing a captioning system for school use that is affordable, easy to use, and appropriate to the varied needs of students who are deaf or hard of hearing. Like subtitles, captions display spoken dialogue as printed words on the television or computer screen. The Need: Without captions, educational media present barriers to the deaf student who cannot hear the dialogue, narration, or other important auditory information. In today's classrooms only a small fraction of educational films and videos are captioned and are often not available when a teacher needs them. An additional problem is that the reading level of some captioned programs is too high for many of the deaf students. The Collaborators: To develop this system, CAST is working closely with CPB/WGBH's National Center for Accessible Media, The Clarke School for the Deaf (an oral communication program in Northampton, MA), The Rhode Island School for the Deaf (a total communication program in Providence, RI), and The Willie Ross School for the Deaf (an integrated program in the East Longmeadow Public Schools, East Longmeadow, MA).

The Goals

The main goal of this project is to design and develop a school-based captioning work station (initially on a Macintosh platform) that will make it possible for teachers to caption a variety of media, making such materials accessible to deaf and hard-of-hearing students. A secondary goal is to explore the uses of this system as a way for students to write their own captions for educational materials, including their own video productions and plays. Based on needs assessments conducted at each of the three pilot schools and other survey information that will be collected through the course of the project, we are designing a captioning system that will provide increased flexibility for teachers and students. With school-based captioning, teachers can create captions for educational materials of their own choosing or for materials they create themselves. They can produce these captions in a variety of reading levels, in varying text styles and colors, and with other expanded captioning features. This captioning system extends beyond limitations inherent in traditional captioning. Traditional captioning can only be displayed in a single font with white text on a black background, and is almost always displayed in all capital letters. This project's captioning station transcends these limitations by producing "object-based captioning". With object-based captioning, captions can be comprised of many kinds of objects: text, icons, pictures, or even QuickTime movies. Text and other objects can be displayed in multiple colors on multi-colored backgrounds. Additionally, text can be displayed in any font, size or text style, and captions can be easily placed anywhere on the screen.

Additional Benefits

While it is clear that deaf and hard-of-hearing students benefit from this project, we are also exploring the benefits of captions to students with other language impairments, to those students for whom English is a second language, and to regular education students. Greater access to media enhances student learning and promotes inclusion in mainstream classrooms for all students.

Special Session (M1-302AA)

Unreal Cost of Exemplary Teaching With Computers—What to Do?

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Key words: costs, budgeting, planning, staff development, teachers

Abstract

Two previous studies conducted by the presenter raise questions about the feasibility of accomplishing exemplary computer-use practices among all teachers. The first study showed how the teaching environments of exemplary computer-using teachers differ from those experienced by typical computer-using teachers. For example, they are much more likely to work where a full-time computer coordinator is present on-site and where a network of other computer-using teachers exists. The second study estimated what it would cost to create optimal teaching environments for all teachers in a school. That study found that personnel-related costs (e.g., smaller classes, formal training, support staffing, and time for colleagual networking and curriculum-integration planning) were more than twice the cost of a technology-rich hardware and software inventory, and could conceivably cost as much as $1,400 per pupil per year.

This session will summarize the two studies and then consider alternative approaches to dealing with their implications for technology planning. Approaches will be suggested involving (a) unequal concentration of resources across schools and subjects, (b) wholesale commitments of contributed time by teachers and administrators through team-building leadership strategies, and (c) compromises in terms of potential accomplishments and technology investments forgone. Additional suggestions from the audience will be entertained.

Special Session (M1-304A)

Functions as Objects: Cognitive and Educational Issues

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Key words: functions, functional languages, higher-order procedures

Abstract

In computer science and higher mathematics, the notion of "function as object" is pervasive: functions are passed as arguments to other functions, returned as the values of function calls, collected into data structures. Derivatives, integrals, Fourier transforms, universal Turing machines, composition of maps, object-oriented programming constructs, groups of operators—all may be seen as instances, in one form or other, of the use of functional objects. But despite the importance of this notion, it has proven notoriously difficult for students to understand.

In recent years, a variety of exciting computational tools and languages have offered students new avenues for exploring the notion of functional objects. The MultiMap and Function Machines systems (both created at BBN) are examples of mathematical tools for representing functions in novel ways; interactive programming languages such as ISETL and Scheme likewise present powerful methods for manipulating functional objects.

This panel will discuss some of the pedagogical and cognitive issues involved in treating functions as objects. We will look at the ways in which computational media have changed the representational landscape for functions; we will discuss the problems that students appear to have in dealing with notions of "higher-order functions"; and we will suggest some directions for future research in cognitive science and software design.

Distance Learning (M1-306A)

Scientist in Electronic Residence

Chris Viegaard

Participate in the following live broadcast

Arthropods are the most diverse and successful group of animals on earth. This large taxonomic group includes insects, spiders, centipedes, millipedes, and crustaceans. The Amazing Arthropod series, designed for grades 3-5, will focus on many adaptations that arthropods possess (body structures, sensory organs, and behaviors) that are responsible for their tremendous success in a wide variety of habitats, including tropical forests, deserts, and aquatic echosystems.

Dr. Fernandes will bring an exotic collection of live specimens into the studio to demonstrate the similarities and differences among members of this group. Hands-on classroom activities will encourage a better understanding of how arthropods perceive the world around them, find food, and attract mates.

Scientist

Dr. Donna Fernandes is an invertebrate specialist and Research Consultant for the Franklin Park Zoo. Dr. Fernandes now works as an exhibit designer for zoos and aquariums. She is a repeat presenter on the Mass LearnPike.

Materials

Materials will be sent to all registered sites for a variety of hands-on activities. Participants will need to provide :

- Clear containers to hold live specimens
- Scissors, pencils, crayons, masking tape
- Glass jars, two-liter plastic bottles, or similar containers for an arthropod habitat
- Overhead projector (only for fourth session)
- Poster board for each student (about 28" x 22")

Project (M1-308A)

Look, That's My Language: Word-Processing for a Multiilingual Society

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Key words: word-processing, languages, multicultural, multilingual, Allwrite

Abstract

London is a multicultural and multilingual city where as many as one hundred and seventy-six languages are spoken. Since the mid nineteen-eighties, ILECC, a not-for-profit educational computing centre serving schools in the London area, has been attempting to meet the needs of the capital city's children by developing and supporting a multilingual word processor. *Allwrite 2* is now available in an IBM-compatible version and is used far beyond London. The program also won a British Design Award. Our aim at ILECC was to provide low-cost word-processing, whatever the style and laterality of the script involved. This means that not only are European languages available, but so are many of those from South Asia and the Indian sub-continent.

The language list is growing all the time, but currently includes Arabic, Bengali, most European languages, Farsi, Gaelic, Greek, Hindi, Ijaw, Panjabi, Tamil, Turkish, Urdu, Vietnamese, Welsh and Yoruba. In many cases, the on-screen messages are also in the language selected. The handbook is pictorial and intended to be easily understood by those for whom English is not a first language. Following a demonstration of the program, there will be a description of the Parents, Allwrite and Languages Project, which involved the use of Allwrite to encourage the involvement of ethnic minority parents in the life of the school.

This project was funded by the Calouste Gulbenkian Foundation and involved work in six schools across England where there are large numbers of bilingual children. A summary will be given of the issues that arose during the project, including the mechanisms developed to encourage parental involvement in schooling. There have also been exciting developments for the future regarding fax links across Europe between speakers of ethnic minority languages, and these will be described and it is hoped to add an American link to this process.

Project (M1-308B)

Nonverbal Foreign Language: Finally a Way to Teach It!

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Key words: nonverbal, foreign language, multimedia, HyperCard, videodisc, linguistics, speech analysis

Abstract

"In The French Body" (Dans la peau des Français) and "In The German Body" (In deutsche Haut geschlüpft) are computer-driven, interactive videodisc materials produced through a grant from FIPSE (Fund for the Improvement of Post

secondary Education/U.S. Department of Education). The project's goal is teaching the totality of language and communication. Interactive video is the key to expanding foreign language teaching to include the special verbal and nonverbal cues of face-to-face interaction. Recent advances in speech analysis software have been incorporated to enable student feedback for the improvement of intonation performance.

Print material has always afforded random access to text a reader wants to find, quote, or analyze. However, students, teachers or researchers wanting to study nonverbal behaviors have not had any easy way to do so. Threading and rewinding film and videotape has up to now forced the student of the nonverbal back to something as cumbersome as reading scroll documents in order to get at information. The "In The French Body" and "In The German Body" computer software combined with videodiscs portraying real native speakers in natural, unscripted conversation are designed to permit serious study and learning of the behaviors that comprise from 50% to 70% of real communication.

This unusual work began 20 years ago with Laurence Wylie's work at Harvard University in organizational behavior and nonverbal communication in foreign cultures. The novel techniques Wylie devised for teaching native-like rhythm and kinesic accuracy were hindered in their dissemination by two obstacles: (1) No available materials. Wylie's films were not commercialized, nor was the customized Bell & Howell film projector used to show them a feasible delivery system; (2) No available teacher training in the teaching techniques or use of the materials. By harnessing multimedia technology we have been able to overcome the first obstacle. We will deal with the second obstacle in a proposed second phase of the project. We are reinvigorating interest in this fascinating topic by providing distributable materials on a delivery system that is increasingly available in secondary and post secondary settings. We hope to maintain the momentum through an aggressive campaign of teacher education using several media such as satellite workshops, an E-mail discussion group and on-site training sessions.

The video material consists of 11 conversations (9 for German) on a 30-minute CAV videodisc each lasting from 30 seconds to 2 minutes. The native speakers on these videodiscs are not actors. They were taped in their native country and represent individuals in a social network. From among 160 conversations, these few were chosen by a panel of native speakers and teachers based on criteria including naturalness, range of age, range of register, interest of content.

Students learn these conversations using a kind of "method acting" approach. The student is sensitized to what is happening both verbally and nonverbally through activities prescribed by the teacher's guide to this material. The *HyperCard* software has features to help the teacher present various aspects of the conversations in class. (A DOS version of this software may become available by 1995.) During lab time, students use the special SpeechLab™ stack that is provided for each conversation. Using this software and a MacRecorder or Apple built-in microphone, the student learns the proper intonation patterns for this conversation.

Good intonation along with pacing contribute to a natural, native-like delivery. When nonverbal features are incorporated, the student acting out these conversations comes very close to feeling what it feels like to communicate like a native speaker. This experience of competence goes far to boosting the student's confidence and to helping the student understand what it really takes to communicate like a native speaker.

Project (M1-308C)

ESL Courseware Development

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Key words: ESL, E.S.L., courseware, software, development

Introduction

In the summer of 1991, Touro College began an ESL software development project. The first stage was to look at available software. When we did not find anything that met our needs, we obtained funding from the Office of the Dean of Faculties to develop our own software.

While there are many good adult education and K-12 language and reading products, these products are not suitable for the learning level of ESL students because the average ESL student is literate and educated in his native language. Adult educational software is often too boring to sustain attention.

After much research, Exceller Software was located. Exceller Software is a leading innovator of language software. They have been producing language software for the State Department and other government agencies since 1987. The software consisted of an engine that drove pre-written and prerecorded exercises. Exceller had been using hardware and software to record and play back oral exercises since 1991. However, the company did not have a core of exercises to sell with the engine. In addition, Touro's technicians felt the software needed improvements. Touro College and Exceller Software negotiated an agreement to develop jointly the core exercises for the Exceller program and to improve the software itself.

Then an authoring team of English professors was organized for this project. These professors were assigned the task of authoring original exercises, proofreading the exercises, and adapting textbook exercises for computer input. The authoring team was lead by a resource coordinator who was responsible for securing permissions from copyright holders.

Program Description and Operation

Exceller Software takes sentences and displays them on the screen with predefined blanks. The contents of the sentences used by the software were taken from the same texts that are used in the ESL classes in addition to original sentences authored by professors from Touro. It was hoped that this would encourage self-paced advancement among Touro students.

In addition, Exceller has a speech component that includes oral exercises: listen and repeat, listening comprehension, and listening dictation.

Program Customization

We based our software contents on the structure of our courses and texts that are used in our classes. With permission from Prentice Hall Regents, the contents of Basic English Grammar, Fundamentals of English Grammar, and Understanding and Using English Grammar by Betty Schrampfer Azar were reformatted for use by the computer software. It was hoped that this would encourage self-paced advancement and self-study.

The exercises were divided into Beginner, Intermediate and Advanced Levels corresponding to the first, second and third level classes offered. A variety of computerized exercises were added that were not possible from the texts, such as jumble type exercises. In addition, the exercises could be custom-tailored to the specific linguistic differences between English and the native language of the immigrant students. For example, the beta test site was composed of a large population of Russian immigrants. Russian does not have articles and prepositions. Therefore, many exercises were written to teach these components.

Entirely original dialogues were written by the speech department for the oral exercises which are integrated with the grammar and the reading exercises so that one reenforces the other.

Program Evaluation

The software's limitations on sentence length had a negative impact on the quality of the exercises. The staff felt that most exercises were boring because sentences had to be shortened to conform to the program's format. Students felt the same. These anecdotal observations led us to modify the software.

In addition, the reading comprehension exercises seemed to work in a reverse order. First the comprehension questions were displayed, followed by the reading passage. A student could easily change between a reading passage and the questions by pressing a button, but the procedure was confusing and awkward. In addition, due to the character limitation of the sentence, reading comprehension questions had to be abbreviated and often only two choices as possible answers could be offered for multiple choice questions.

The oral exercises did not seem to work properly until they were run from a network which allowed for faster program operation. Also, the voice equipment was non-industry standard and external to the computer. The voice equipment was not available as a micro- channel circuit board. This increased the complexity of operation, and it was too difficult to explain the operation to the ESL students considering the language barrier.

Program Enhancement

The original Exceller product was written in DOS. Exceller Corporation, in coordination with the computer technicians from Touro College, rewrote the software with Toolbook, a Windows software development tool.

Windows is a graphical, computer environment. Primarily, programs are run and actions are taken by using a mouse (a pointing device) to select icons. This Graphical User Interface (GUI) is much easier for the average person to master and seriously reduces the training time for computer illiterate students. Training ESL students to use a computer while overcoming the language barrier is most difficult, especially for low level students. The Windows GUI helps overcome this problem. Also, the Windows environment is easier to use with fewer keystrokes.

Furthermore, Windows is a device-independent operating system. For example, a program such as Exceller can be written generically to use any speech card. Using another speech card does not require reprogramming as it would in DOS, since the Windows operating environment handles the interface between the program and the speech card. All that is needed to use a different device is the installation of another device driver. This allows the developer and end user flexibility when evaluating and purchasing hardware.

Toolbook is a complete object-oriented development environment with graphical drawing tools. It is easy to quickly design and build appealing applications. For the exercises written in Toolbook, existing commercial clip art was used to illustrate examples.

Rewriting the Exceller program in Toolbook allowed for virtually unlimited sentence length and pictorialization of nouns and actions, with stills and animated clips. Reading comprehension could now have multiple choice questions with four wordy answers. Also, the ability to change from question to question, exercise to exercise and subject to subject was added. In addition, it was now infinitely easier to operate voice equipment.

Further Software Research and Development

Certain types of exercises — spelling, cloze, vocabulary building, paragraph construction, sentence sequencing, writing and authorable reading comprehension — were not available at all.

The software project was expanded to integrate other software packages that were available on the market for these functions. However, the inability of most software to enter specific word lists or reading texts was a major drawback. It was imperative to purchase software that worked with a user's data. Standard ASCII text files was the normal format for programs that worked with a user's data.

This feature became a mandatory requirement for purchasing consideration. It gave a tremendous advantage that allowed for parallelism with texts in the classroom, customization for a group's specific language background, and adaptation for a particular learning level.

Two excellent examples of this are "Word Attack" which allows individual word lists such as the TOEFL word list, in addition to the word lists provided by the vendor and "Text Tanglers" which provides both its own texts as well as individually authored text for spelling, cloze, vocabulary building, paragraph construction and sentence sequencing.

Summary

CAI is very motivating and captivating for most students. It can keep the students interested and stimulated for extended periods of time working on drill exercises in grammar, paragraph structure, cloze, spelling and vocabulary building. Non-drill exercises such as writing compositions are not enhanced directly with CAI software. However, the use of computerized word processing may be quite helpful as a tool but not as a learning device for a non-drill exercise.

Whatever software is used, the ability to enter data tailored to the students' specific language background is very important because it improves learning by focusing on specific grammatical differences between English and the student's native language, and reenforces the correct English grammatical format. If it is not custom-tailored for a specific language background, the students are not given that extra focus and reenforcement.

Ease of operation is very important. Equipment too cumbersome to use is ineffective. The Windows environment and the GUI simplifies the use of computers and programs to make the training process break the language barrier. In addition, operating a multi-colored, graphical program is so stimulating that students can be motivated to concentrate for long periods of time.

Special Session (M1-310A)

Reinventing Middle School Mathematics Classrooms with Technology—Perspectives from Practitioners (A Panel Presentation and Discussion)

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Key words: mathematics, technology, training, in-service, adolescence, projects

Abstract

This panel presentation will involve educators who are engaged in collaborative projects (school districts and universities) whose purpose is to revitalize mathematics instruction through the use of technology at the middle school level. They will be sharing what they have learned from being on the "front lines" of a movement that is reshaping the learning and teaching of mathematics.

Summaries of Participating Projects

Empowering Teachers: Mathematical Inquiry Through Technology

Bolt Beranek and Newman, Cambridge, MA

Through graduate courses, in-service workshops, and interactive satellite based distance learning courses this NSF sponsored teacher enhancement project is focusing on a comprehensive teacher education program to foster the strategies, art, and practice of mathematical inquiry teaching in middle school mathematics classrooms. The program employs interactive computer software and video technology as key instructional tools for fostering the development of inquiry learning and teaching skills. Currently two new courses are being designed: Animated Geometry and Interactive Algebra, that draw extensively on computer activities to support inquiry teaching.

Leadership Infusion of Technology in Mathematics and its Uses in Society

University of Georgia, Athens, GA

Project LITMUS was created in response to a special solicitation from the National Science Foundation which specifically targets the need for in- service education of mathematics teachers grades K-12 to enable them to integrate computing technologies in their regular classes. This project represents a major effort in the reform of mathematics teaching practices throughout two school systems. The use of computing technologies is seen as the catalyst for this reform effort. The project will attempt to develop and evaluate a model for the system-wide infusion of computing technologies in mathematics instruction which could be adapted for use by school systems throughout the nation. The core of our model is the development of Leader Teachers in every school in the system. These Leader Teachers are becoming expert users of technology in their own learning and teaching and will act as mentors for the other teachers in their schools. All Leader Teachers have Internet accounts and most of the communication is by E-mail. The project also has a support team of graduate students and project staff who make regular trips to the classroom.

Enhancing Mathematics Instruction Through Computer-Oriented Active Learning Environments

Stevens Institute of Technology, Center for Improved Engineering and Science Education (CIESE), Hoboken, NJ

This mentorship project provides intensive training and support to 45 middle and high school teachers in 16 school districts in New Jersey. The project uses computer software and calculators as catalysts for creating classroom environments that are more constructivist in nature and promote active learning. After developing several personal models for using technology involving one computer classrooms, classroom labs, and computer labs, the teachers will act as mentors for their schools and school districts. In addition to the mentorship project, CIESE is engaged in a national outreach effort which includes a videoconference series produced in cooperation with New Jersey Network and distributed to a national audience by the Satellite Educational Resources Consortium (SERC). There is a "hands-on" component that is done in collaboration with community colleges.

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Empowering Mathematics Teachers in Computer-Intensive Environments

Penn State University, University Park, PA

This teacher enhancement project funded by NSF has sponsored a Computer-Intensive Mathematics Education Institute (CIMEI) that seeks to empower secondary mathematics teachers to teach in environments that assume continuous access to a variety of computing tools for investigating mathematical ideas. Project activities include the implementation of an innovative curriculum, Computer-Intensive Algebra, that focuses on the application of mathematics and the development of its understandings. CIA provides students with an opportunity to explore mathematics in real-world situations through development and evaluation of mathematical models.

Special Session (M1-311A)

Imagining IMAGINE: A HyperCard Environment for Teaching a Technology-based Curriculum

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Key words: science, gender, teacher development, K-12 curriculum, technology education, engineering

Abstract

IMAGINE is a computer-based graphics tool, intended to provide girls with alternative pathways into the world of machines and engineered objects. In using *IMAGINE*'s paint and animation capabilities, girls are encouraged to start from their own interpretive vantage points—dreaming up devices that are not necessarily realistic, but serve to legitimate their experience of themselves as designers and inventors.

With support from the National Science Foundation, researchers and designers at the Center for Children and Technology have refined the *IMAGINE* software and developed a supporting curriculum to be used by educators in both in-school and out-of-school settings. The curriculum is designed to take girls through a series of activities which invite them to brainstorm and reflect on the process of designing machines. In order to support teachers in understanding the *IMAGINE* software and the accompanying curriculum, we created a *HyperCard* environment (the *IMAGINE Tour*) to introduce teachers to the *IMAGINE* experience. The environment draws together a variety of information from the research and development phase of the *IMAGINE* project. Using examples of students work, curriculum activities, and reflections from the research that are included in the *IMAGINE Tour*, participants will have the chance to explore the curriculum activities that led to the students' design ideas, and to learn more about the pedagogical issues that arose in the classroom.

Special Session (M1-312A)

Copyright & Intellectual Property Issues in a Networked Environment

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Key words: copyright, networks, policymaking

Abstract

The use of technology to both generate and disseminate information electronically provides educators with a host of new challenges. This panel takes a look at the emergence of integrated and affordable data network "highways" that will allow ready access to digitized voice, data, image and video information—what are the issues involved? Schools have an important role to play in both the formulation of policy and educating students on the values, policies and laws that suit a rapidily changing, technology-oriented world. To be effective in this role, educational policy makers must understand the ethical dilemmas and legal issues raised by use of new information technologies in schools.

Project (M1-313A)

Multimedia as an Assessment Tool: The Impact of Technology on Portfolio Assessment

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Key words: multimedia, assessment, portfolio, high school

Abstract

As part of a mentorship at Albany High School for the 1992-93 school year, I used a word-processing program, a *HyperCard*-type program, sound, video, and still-videos to create student and teacher portfolios. These portfolios were used as part of an on-going process in teacher-based research on assessment. One of the greatest difficulties portfolio assessment has presented to students and teachers alike has been storage; teachers tell of voluminous files containing student work that at some point impedes directly the assessment process.

However, if at least some parts of the portfolio or if at least some of the portfolios can be inputted to or done directly on computers using word-processing and multimedia technology, the assessment process is often more directly available. In addition by using the multimedia capacities (my particular approach represents only the tip of the iceburg for the future of multimedia and portfolios), the student can demonstrate many different kinds of learning (and the teacher many different kinds of teaching) with sometimes remarkable results.

The portfolios I developed came a) from a senior, non-college track composition course, b) an English I unit in poetry, c) a portfolio of my own work from an Outdoor Education Seminar with students in which I modeled how to write on the spot using the rural setting as inspiration, and d) a specific lesson on the seminar process which I used as a model for

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evaluation of teaching this lesson to student teachers. Each of the four demonstrates a slightly different utilization of the technology in order to allow the individual teacher or student room for individual creativity.

Special Session (M2-BRAA)

Don't Copy That Floppy

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Key words: ethics, law, software management

Abstract

With the increase of the use of technology in the schools, teachers and administrators are having more and more software to manage. This session will discuss the current laws and will provide ideas for managing software at the district and school levels while staying in compliance with the laws.

Special Session (M2-BRCA)

Preparing the Communicators of Tomorrow

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Key words: CD-ROM, global community, word processors, communication, multimedia, vision

Abstract

At one time, colleges accepted handwritten work. When most of the current population of educators went to college, typewritten materials were required. For some time now, projects produced with a word processor have been virtually expected for the final appearance of collegiate and university student submissions.

While the world at large has moved beyond the handwritten page and newspaper to a satellite-linked global community, and the formats of CNN and CD-ROM are already the standard, most schools still consider the availability of word processors, and training in those skills to be their highest aspirations for the use of technology in education.

The question is, will our students be prepared to hand in their college assignments using the skills we are giving them now? More to the point, what is today's classroom doing to give the next generation the communication skills they will require for the present day, where ideas carried by images and sounds as well as words are the norm?

Body

At this very moment, CD-ROM, and the instant availability of immense amounts of factual information through a variety of sources have rendered the role of the teacher as a walking encyclopedia irrelevant. To our credit, this liberation from rote memorization has been accompanied by a new enlightened view of the purposes of the educational process, and changes in the fundamental assumptions about the role of the teacher. The move from an authoritarian dispenser of facts to a partner and guide in learning and navigating a new world of knowledge will make the classroom a richer and more enjoyable place for both the student and the teacher.

At this very moment, virtually every major book publisher is in the process of producing their printed works in electronic form, with some new titles being available ONLY in that form. The day is truly not far off, when a youngster, having just finished touring "Where the Wild Things Are" on CD-ROM, will be prompted by their teacher (or parent) to write their own story, be offered pencil and paper, and the child will react with a quizzical look, and a question about whether this is an exercise in historical awareness. "But how do I make my story like THAT?", they'll ask. Not only do few schools offer the answer to the question of the specific tool to use, still fewer can offer real guidance on the overall skills of that creative process.

It is critically important that educators begin now to consider not just the use of technology in the classroom as a tool, but also start planning how students will be taught to communicate using these tools in a competent manner consistent with the world they are entering. Just where does one find Strunk & White's "*Elements of Style*" for multimedia writing?

1. In this session, discussion of these issues will include examples of projects, both from the commercial venues of the "real world", and from the current work of classroom students in a variety of grade and subject areas.

2. What hardware is really required to teach the core skills of communication in a multimedia environment? It may come as a surprise to many that advanced systems are not always required, and that in fact, equipment has been in the schools for years that is capable of facilitating the basic processes of this contemporary form of information and expression.

3. The software is an equally important part of the implementation, and most of the software currently available was designed with either a commercial developer, or business presenter, in mind. The software should be targeted specifically at education, and facilitate and encourage multimedia-based projects without requiring an unusual degree of technical knowledge. Software which does this, and which also supports the important educational principles is rare, but fortunately available.

4. Along with the assumption that multimedia requires impressive (and expensive) equipment and software, many people may feel that all the new options in computers make using them more difficult, and that greater and greater technical skills and awareness are necessary. On the contrary, though, technology has been become more and more "consumerized" with each passing year, and at this time, the use of technology, and in particular multimedia, is increasingly found in elementary classrooms! Elementary school students are in many ways the most demanding on technology from a "let's just get the job done with as many creative options, but as few obstacles, as possible" point of view.

It is ironic that many educators in the later grades assume that the earlier levels are using "kid multimedia", when in fact they are conducting something closer to what would be considered commercial multimedia use, at least in terms of process, than most high schools and colleges. In fact, one of the most likely actual mechanisms for change in secondary education will come from the students who move from the rich technology environment of the primary schools in this country to the comparatively technology-poor environment (in inventory, but especially effective use) of the higher grades.

A growing challenge is from an instructional standpoint. What is the grammar of a multimedia screen? What is the proper way to prepare the outline of a non-linear, and only partially linguistic project? How shall assessment be done? In what form should archives of student projects be kept?

It is the belief of the presenter that many of the necessary skills are already at hand, although perhaps from areas that did not previously participate in the traditional composition class, particularly skills from the liberal arts. Each will now have important approaches and insights to contribute.

From the art department will come concepts of color, balance, and the use of images to convey emotions as well as information. Graphic design and composition will supersede the rather trivial definitions of margins, page layout, and other aspects of an increasingly anachronistic printed page. The music department will offer expertise in the proper contextual use of music and sound as the background to a story, and the drama department's knowledge of communication art at a human level will be welcomed. Best of all, however, is that the very concept of "departments" will very properly disappear as the creative and expressive medium itself mandates an integrated curriculum approach. The science and history classes now find themselves hand-in-hand with telecommunications, and the yearbook class weaves photography and computer science into the fabric of community awareness studies, including both social and environmental issues.

The presenter also believes that the one the most important skills that the communicators of tomorrow will have to master is to learn to first consider the message they wish to convey, and to only then consider the tools available. With the overwhelming flood of new technology and information, it sometimes seems that our technology instruction struggles just to keep pace with teaching about the existence of each new product, rather than stressing the mastery of each only as a tool for each individual's personal goal, whatever that may be.

One should always remember that one of the key foundations to the personal computer revolution is indeed the word "personal". The gift of technology has been the empowerment of the individual, and an underlying respect for the value of each person's own sense of what is worth doing. Too many schools are racing down the path to put glowing books in front of our children, while neglecting to consider how they will teach them to express their own ideas in this new medium. The invention of the printing press liberated the people of the world only when they learned to write their own ideas and create their own content to accompany that rather simple technology of duplicating words. The importance of the written word is told more by the struggles and accomplishments of Galileo and Thomas Paine than the technical achievement of Gutenberg.

It is our responsibility to make sure that the students that have been entrusted to us are made aware of the rich new tools now at their fingertips. We must be prepared to give them the skills to achieve their own life goals, and the ability to effectively communicate their own ideas and individuality with the other members of their global community.

Giving them knowledge, ideas, and new visions, and yet withholding the ability to share themselves with others would be to nurture the mother, yet imprison the child.

Paper (M2-201A)

A Team Software Development Approach for NCATE Computer Science Teacher Preparation

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Key words: accreditation, computer science, NCATE, teacher preparation, team projects

Abstract

Educators in a special institute for secondary computer science teachers participated in a coordinated team software development exercise. The exercise was designed to provide real experience in an active computing environment and to allow students to practice new methodologies that could be used in their own classrooms. This collaborative learning approach to computer science education addresses many of the competencies prescribed by the newly-adopted NCATE computer science education standards. In this paper, the team project methodology for computer science education is presented and its relationship to the NCATE guidelines is explored.

Introduction

Educators preparing to enter secondary computer science classrooms face many challenges. They must acquire technical proficiency in computer science as well as learn the teaching and support methodologies needed to conduct and manage secondary computer science classes and laboratories. Often, educators look to local colleges and universities for programs and training to prepare them for teaching secondary computer science.

Currently, quality and content of computer science teacher preparation programs vary significantly across the United States. New standards (NCATE, 1993) adopted by the National Council for Accreditation of Teacher Education (NCATE) in 1993 provide models for computer science teacher preparation programs that will ensure quality preparation of all participating in such programs. Teachers completing programs based on these standards will participate in a coordinated group of experiences designed to develop competency as computer science professionals and as educators.

A group of secondary computer science educators participated in a special teacher preparation institute at a major university. One final, long-term project was a team software development exercise that included practice in analysis of computer science structures and concepts and exposure to special teaching methodologies that could be carried into the classroom. The exercise and experiences associated with the project addressed in some way many of the competencies found in the NCATE guidelines. In this paper, the NCATE guidelines and their relevance to computer science education are discussed, the team software development project exercise is described, and the relationship between this team approach and the NCATE guidelines is examined.

NCATE Standards

In October, 1993, the National Council for Accreditation of Teacher Education (NCATE) formally adopted standards for computer science education (Taylor, Thomas & Knezek, 1993a). These standards are subject-area standards that provide guidelines for programs that train secondary computer science educators. This action by NCATE, the only national organization in the United States authorized to accredit professional teacher preparation programs (NCATE, 1992), signals that computer science is a true distinct secondary discipline. Furthermore, computer science is a valid speciality area within the field of education with its own unique set of competencies and training requirements.

The NCATE guidelines (ISTE, 1993) are competency-based guidelines which are broken down into two parts: computer science content area preparation and professional teaching preparation. Unlike most older NCATE subject-area guidelines (NCATE, 1993), there are no prescribed courses. Instead, a coordinated group of experiences that build on each other is desired. There is no one place in programs where a specific competency must be addressed. Rather, the goal is that most competencies will be fulfilled by multiple experiences which may span several courses perhaps in both the professional education unit and the computer science unit.

The NCATE guidelines are new and revolutionary for computer science education. Computer science is very visible in American secondary education, but not in a formal way. Not all states offer teacher certification in this field, and those requirements vary greatly from state to state. Likewise, not all states count computer science as a valid secondary subject area. Studies involving computer science often are included within the business or mathematics curriculum rather than carry the label computer science. This formal recognition by NCATE, an organization with enormous respect and credibility within the field of education, may well help standardize many other aspects of secondary computer science beyond teacher training. Standard curricula and certification criteria should soon follow.

These guidelines represent a major step towards the establishment of a discipline. They provide a framework for teacher training programs. Still lacking are implementation models that meet the standards and that can be replicated by others. Researchers must continue to define these programs and the types of activities that are needed. In this paper, one such activity, which touches on over 10 of the competencies, is described.

Team Project Activity

Goals of Project

Educators enrolled in a special summer institute for computer science teachers participated in a coordinated team project exercise (Taylor, in press). This team project exercise was intended to provide experience with collaborative learning in computer science. Moreover, it was designed to achieve a number of important goals:

1. Serve as a mechanism for working with teachers at greatly differing competency and expertise levels to teach computer science concepts;
2. Provide "real" experience in computer science through active involvement in development and design of large projects beyond the scope of students working independently;
3. Teach students advanced computer science data structure concepts at a high level, including differentiation between structures and uses with respect to a given situation;
4. Develop the teachers' abilities to communicate effectively about the discipline;
5. Demonstrate important teaching methodologies for secondary education;
6. Give students practice in modelling teaching methodologies; and
7. Provide for professional growth as computer scientists and educators.

The activity was an overwhelming success by all criteria. Most of the educators had significant prior experience in writing programs and using computer languages. Most had limited contact with other computer professionals. None had ever participated in any type of computer science collaborative activity. They all left the course identifying it solely with this exercise and talking about the ways that their own teaching styles and approaches might change as a result.

Description of Activity

Students were assigned to teams of three people to work on team software development projects. The products were to be menu-driven programs that met a set of specifications handed out by the instructor. Each project had an intended audience or set of users in mind. The interface that was provided for the user was critical to the success of the projects.

The instructor played an active role in team management. A schedule was created which provided for daily team meetings to plan and review progress. The instructor "client" was on hand to answer questions about design features that were under consideration. Particular attention was to be paid to the software engineering aspects of the project. Design of appropriate testing strategies was part of the exercise. The schedule provided for a required testing phase with input from other teams several days before completion.

The deliverables included not only the final program with user and programmer documentation, but also a written report. The report was to identify the higher-level aspects of the project beyond the description of the lines of code or modules in the program. Items to be discussed included:

1. Problem analysis and data structure selection and organization;
2. Description of how the team functioned and developed the product to best utilize the skills of the various team members;
3. Problem areas or critical design decisions;
4. Limitations of the version of the product that was delivered;
5. Possible extensions to the product and similar problems that might be used as classroom assignments; and
6. Types of testing done on the product, potential bugs, and fail-safe procedures that were installed.

The final component of the exercise was a one-hour oral team presentation of the project. These presentations were to be done from the perspective of presentations to co-workers about on-going projects. They were to discuss high-level details similar to those in the written report as well as demonstrate the functionality of the project. These presentations were given as formal presentations in the departmental conference room rather than the regular classroom. The conference room contained various types of audio-visual equipment and presentation aids, including a computer with a data projection device. Many of the teachers got their first experience using such technology in support of their teaching field through this exercise.

Change of class atmosphere

Most of the teachers were skeptical but enthusiastic about the activity. Most had assigned team projects to their classes but had never participated in them. This activity had much more structure and challenge than the normal methodology of assigning the project and the team members and collecting the finished project at a later time. There was constant and lively interaction between team members, between the various teams (each working on a different project), and the instructor client. Teams bonded as units and worked on this and other problems well past normal class time on most days. The class assumed an excited atmosphere not often seen when working with similar groups.

These teachers displayed an unusual zeal for this activity. They had enormous pride in what they had accomplished and expressed new vitality for using similar collaborative learning activities in their own classes. This aspect may be somewhat unique to computer science education. Most secondary computer science teachers are teachers who have retrained from some other primary teaching field. Often, the field is one such as mathematics, where individual work rather than collaborative learning is valued. An earlier study of successful computer science teachers (Taylor & Magoun, 1993) showed that many of these teacher had not used collaborative teaching techniques in their first fields and had only learned the value of such approaches in computer science education through experience. This finding was indeed verified with the group of teachers who participated in these team activities.

NCATE Team Project Requirement

The NCATE Computer Science Education Endorsement Guidelines (ISTE, 1993) subdivide specialty content preparation in computer science into five components. Component four calls for experience in team software development projects. The team activity described in this paper is one of many possible experiences that could be used to document this proficiency.

The team project requirement was one of the most controversial of all of the items in the NCATE guidelines (Taylor, Thomas & Knezek, 1993a; Taylor, Thomas & Knezek, 1993b). Reviewers were either wildly in favor of the requirement or adamantly against it. Some readers were confused as to the exact meaning of the requirement and what types of experiences were envisioned. One extreme might be a senior-level computer science analysis and design course. Few educators have or will have sufficient computer science background to participate in such courses. Another possibility might be a team multimedia courseware development project in conjunction with an educational technology course. A wide range of experiences is possible. The exact number of such experiences and depth is left to be defined.

Computer scientists usually work in collaborative atmospheres. Few work independently without consulting others or interfacing with them. The ability to work within a group and manage group activity is therefore fundamental to a computing professional. Likewise, it is fundamental for secondary computer science teachers. They are often the first computing professionals that pre-college students encounter. Their students' ideas and images of the profession are frequently formed from these experiences. In addition, resources in most secondary schools are limited and students are plentiful. Group activity is often a necessity just to allow all students access to equipment and to manage classroom and lab time effectively.

Other NCATE Competencies Addressed

This activity could be cited as evidence of partial fulfillment of many other NCATE competencies in addition to the team software development project requirement. These include competencies in both the computer science content area preparation section and the professional teacher preparation section. The following two sections identify and discuss some of the competency guidelines that could be addressed by this exercise.

Computer Science Content Area Guidelines (ISTE, 1993; NCATE 1993)

Item 2.1.1 *Functional knowledge of programming in a high-level language, program design, and verification methodologies.*

- The project provided hands-on experience in programming, design, and verification. The project was a concluding exercise to a two-course sequence in which the language Pascal was used as a programming tool. In particular, this exercise is well-suited to address the question of the knowledge level required by the competency. The exercises requires demonstration of functional knowledge of all of the concepts outlined.

Item 2.1.2 *Advanced knowledge of data structures and algorithm analysis.*

- The projects that were assigned all required advanced knowledge of data structures and principles of data abstraction. They all involved applications best suited to binary tree structures and contained significant file organization and management components.

Item 2.2 *Programming and laboratory experience to demonstrate advanced knowledge in at least two high-level programming languages.*

- Participants in this exercise demonstrated advanced knowledge and proficiency in one high-level language. Experience in a second language would still be necessary.

Item 2.5 *Development of written and oral communication skills related to the field of computer science.*

- Students discussed computer science concepts and issues during team meetings. The project required a written report and oral presentation that addressed computer science issues related to the project. The activity might fulfill the part of the requirement calling for at least one oral presentation. It is good preliminary background to a course that includes the required research paper.

Professional Teaching Preparation Guidelines (ISTE, 1993; NCATE, 1993)

Item 3.8.1 *Identification and modeling of communication of concepts.*

- The team meetings and discussion component of this exercise in addition to the oral reports provided the students with far more expertise in this area than hours of lecture might have achieved.

Item 3.8.2 *Identification and modeling of a variety of teaching and grouping strategies.*

- Again, one specific strategy was explored. It is reasonable to expect that several activities would be needed to fully document this item in the NCATE guidelines.

Item 3.8.3 *Functional knowledge of strategies for dealing with different learning styles and diverse populations.*

- The students were challenged to work as teams. Each team was selected to include individuals with vastly different learning styles and abilities. Teams also included both male and female members. One of the main chores for the teams was to determine ways to utilize each individual to help the team. This often resulted in one of the team members actually teaching the others some concepts or programming practices. Certainly this activity does not reflect the full scope of this particular guideline, but it could be cited as partial evidence of proficiency.

Item 3.8.4 *Functional knowledge of methods of assessment and appropriate feedback techniques.*

- Students were actively involved in providing feedback, both during team meetings, testing sessions, and during the conference-like oral presentations. As the exercise progressed, the teachers acquired increasing proficiency in expressing their concerns and problems and interacting in positive ways about the projects.

Item 3.9 *Functional knowledge of designing, developing and evaluating laboratory activities for the computer science classroom.*

- Students acquired knowledge about the design of lab activities and explored possible similar activities that might be used successfully in the secondary classroom. They also identified and discussed ways such activities could be used in conjunction with other subject areas to enhance learning. The central question in this competency is the level of knowledge. There was significant discussion of key issues involved in this item. The only actual exercise that required some demonstration of this proficiency was a component of the written report. Again, it is uncertain that this exercise alone would achieve the level of competency required to completely fulfill this item.

Item 3.10 *Development of laboratory management skills necessary to support computer science classroom activities.*

- The teachers managed their own machines and time. During the course of the exercise, a strange, almost lethal virus attacked the lab and some of the students' home computers. We were all involved in identifying the virus, eradicating it, and protecting the products from future contamination. Likewise, the students managed the equipment for the oral presentations and the sharing of files between multiple machines. Each team developed its own management plan and also learned aspects of working as facilitators of learning from the model presented by the instructor client in the exercise.

Conclusions

The recent NCATE-approved computer science education guidelines provide standards for secondary computer science teacher training programs. Programs must involve coordinated experiences in both computer science as a subject area and teacher preparation specifically directed at the secondary computer science classroom. Universities seeking NCATE accreditation must prepare folios (Abramson, 1993; Thomas, 1992) that document experiences within their computer science education specialty programs that provide the level of knowledge or competency required by each of the standards. Often, multiple experiences will be cited in fulfillment of one particular item.

Quality computer science education programs will include activities that integrate the subject area with the teaching methodologies associated with it. Computer science teachers often bring with them methodologies learned from other content areas and must be exposed to methodologies associated with the field of computer science as well. The team project activity described in this paper is one type of activity that achieves this goal. It combines content and methodology. It builds on prior experiences and learning. It could be used as partial evidence in fulfilling many of the NCATE competency areas.

Computer science education is still in its infancy. Little is known through research about its methodologies. The project described here involves a fairly standard method of the computer science classroom. Other researchers must now develop and test methodologies and disseminate this information as we document the true content of the field of computer science education.

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Paper (M2-201B)

Research on the IBM Grant Program's Impact on Teacher Preparation

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Key words: technology integration, teacher preparation, education

Abstract

Despite technology's potential for transforming education, it has yet to influence many classrooms, often because teachers are untrained in its use. In 1990, IBM contributed over $30 million dollars in hardware, software, cash, and training to prompt 144 teacher preparation programs to integrate technology into their curricula. This study was conducted, in part, to determine what impact this contribution has had on teacher preparation. As reported below, a large proportion of teacher preparation faculty members has been trained on IBM technology, and the numbers of pre-service and in-service teachers so trained increased noticeably each academic year, over three reporting periods.

IBM Grant Program

The great potential of educational technology (Bitter, 1970, 1981, 1987, 1991), and the many failures in educational technology innovation, (Drazdowski, 1990; House, 1974; Gayeski, 1989; Tornatzky & Fleischer, 1990) require research-based knowledge on the effective integration of technology into education, and especially into teacher preparation. As a contribution to increased and enhanced integration of technology into teacher preparation, and especially into teacher preparation, International Business Machines (IBM) conducted a nationwide grant program. Selected teacher preparation programs, across the country, received grants that typically included 15 IBM model 25 workstations, a fileserver, networking hardware and software, IBM courseware, a cash grant of $5,000.00, free training for two people from the project, and technical support.

To facilitate organization and communication within the grant program, IBM created nine regions, each headed by a regional coordinator, which was also a teacher preparation project site. The major investment of time and other resources by IBM and by the projects required an assessment of what impact this grant program has had on teacher preparation. Technology Based Learning and Research (TBLR) at Arizona State University was funded in November, 1992 to conduct a national study that would meet this need.

Evaluation Objective and Method

The goal of the evaluation was to provide a coherent understanding of what has been learned from this program and what its contributions were to knowledge about the integration of technology into teacher preparation. The objective on which this paper focuses was to determine the grant program's impact on teacher preparation.

Based on the materials received from the sites in the fall of 1992, and preliminary discussions with regional cooect directors, a questionnaire was designed to collect updated contact information from each site. After piloting the instrument through telephone interviews, copies were sent by facsimile to the sites. Repeated attempts by telephone and facsimile to reach non-respondents resulted in a response rate of 92%.

A variety of means could be used to determine the impact of the IBM grant program, but the most important measures must include the populations who were served by the IBM laboratories. These included Teacher Preparation Program (TPP) faculty members, pre-service and in-service teachers.

Populations Served

TPP Faculty

Of all the populations served, arguably the most important for the long-term impact of technology on instruction, is the TPP faculty. New assistant professors might typically serve for 35 years. Based on an average of four classes per semester, with 30 pre-service teachers per class, new full-time TPP faculty members might affect 240 pre-service teachers per year, or over 8,000 in a career.

As pre-service teachers usually teach much the same way they were taught, the influence of TPP faculty members can be an enormous influence on future instruction in the schools. Table 1 reports the number of full-time and part-time TPP faculty members reported by responding sites. (The number of sites who responded to these questions are indicated in parentheses.)

Full-time (N=90)	**Part-time (N=66)**	**Total**
3633	1617	5250

Table 1. Number of Faculty Reported by Teacher Preparation Programs

Of these faculty members, the majority (63%) have been trained on IBM equipment, as illustrated in Figure 1. As shown, the overwhelming majority of those trained on IBM equipment were trained as an outcome of the project.

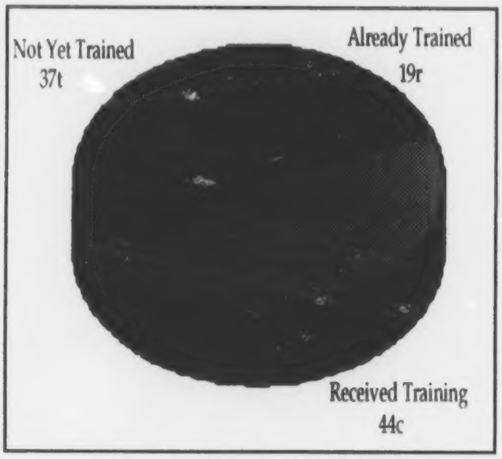

Figure 1. Percentage of Faculty Who Received Training on IBM

Thirty four percent of the sites (49 sites) reported on changes in faculty attitude toward the project's IBM laboratory during the course of the project. As illustrated in Figure 2, the great majority of these changes were positive. Table 2 reports responses associated with both positive, and negative, changes in attitude.

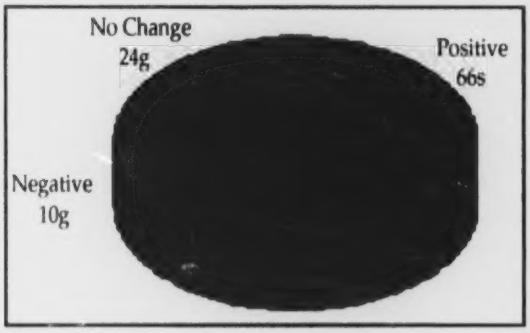

Figure 2. Change in Faculty Attitude Toward Project's IBM Laboratory

Positive	Negative
"Faculty realized that the IBM lab could be pedagogically integrated into all Pre-K to 6 curricula."	[The grant provided] "Outdated equipment."
"Lab has acted as a prompt to encourage and support the continued study and consideration of technology in all of the math classes within the math department."	[We had] "More Apple familiarity."
"More willingness to try technology; in-service programs help a lot."	"Software marginal, could use software that encourages higher-order thinking skills."
"The easy access to the network encouraged the faculty to try to integrate IBM technology into their classes, and helped them see the value of a computer network in the learning and teaching process."	[We needed] "More internal support."

Table 2. Responses Describing Attitude Change

Pre-service teachers

A large number of pre-service and in-service teachers have been trained on the IBM equipment provided by the grant program. Figure 3 illustrates the growth trend during each of the three most recent academic years. For academic year 1990-91, 65 sites reported having utilized the IBM labs for pre-service teacher training. For 1991-92, this number increased to 82 sites and for 1992-93, the number had increased to 89 sites. Over 52,063 pre-service teachers have received training on IBM technology since 1990, through the projects.

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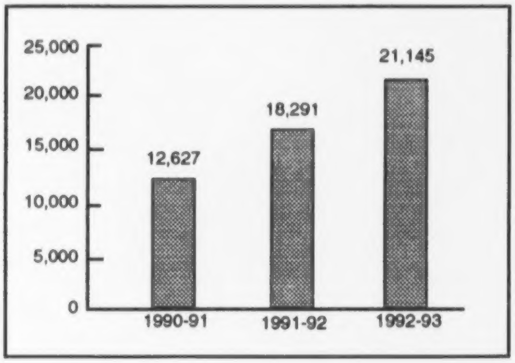

Figure 3. Pre-service teachers Trained in IBM Laboratories (1990-1993)

In-service teachers

Given the predominance of Apple computers in much of elementary and secondary education, it is not surprising that fewer in-service teachers than pre-service have been trained in the IBM labs. As illustrated in Figure 4, however, the number of in-service teachers trained on IBM computers is still substantial. For academic year 1990-91, 56 sites reported having utilized the IBM labs for in-service teacher training. For 1991-92, this number increased to 76 sites and for 1992-93, the number had increased to 78 sites. Over 18,507 in-service teachers have received training on IBM technology through the project since 1990.

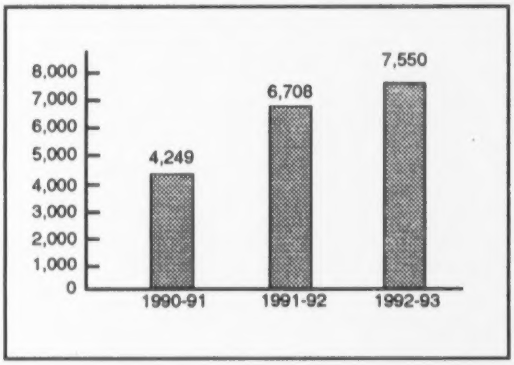

Figure 4. In-service teachers Trained in IBM Laboratories (1990-1993)

A variety of other populations were served by the projects. These included the site's students who were in fields of study other than TPP, the site's faculty in other fields, community groups, and local schools.

Other measures of the grant program's impact include the curricular changes made to integrate the laboratories and the use of those laboratories to leverage both internal and external support. These, and other data too numerous to include here, will be reported in Bitter and Pryor (forthcoming).

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Paper (M2-202A)

Using Hypermedia toSupport Understanding of Expository Text: Examples from the Workplace and Classroom

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Key words: hypermedia, workplace training, content area instruction

Abstract

This paper examines how comprehension of expository text can assisted by using hypermedia support—text, images, and speech. This kind of presentation environment, what we call Responsive Text, can compensate for a reader's basic skills deficiencies by using speech support to aid decoding, hypertext/hypermedia to provide background and vocabulary support, and interactive questions to encourage comprehension monitoring. The paper will describe how a Responsive Text environment has been used for both adults, using workplace training materials, and middle school students, using social studies and science texts.

Body

Text as been the mode of choice for conveying information since the invention of movable type. Unfortunately the printed page has little to offer those with reading difficulties. This is especially true with expository text where comprehension demands are usually higher than narrative text. A typical work-related training manual, for example, contains dense text covering complex procedures. Such instructional texts also convey information using charts, graphs, tables, and calculations that demand competencies beyond those considered as "literacy".

While one can "dumb down" such text by rewriting it to a lower grade level, this often has the unintended consequence of making the text harder (Anderson, Hiebert, Scott, & Wilkinson, 1985). A more thoughtful approach is to make the text "considerate" (Armbruster & Anderson, 1981) by using predictable structure, shorter sentences, and less demanding vocabulary. Studies consistently indicate that comprehension is improved when text is rewritten to be more considerate of reader's needs.

There is a limit, though, to how considerate static text can be. Because paper-based text cannot respond to each reader's particular needs it must be written and revised based on the needs of a single "ideal" reader. We are exploring new ways of thinking about text, based on the use of hypertext and hypermedia, that address some of the problems with text as a training medium.

Responsive Text and Workplace Training

Hypertext and hypermedia are usually thought of as an ***extensive*** medium, the surface text provides a starting point and links lead the reader away to browse among many diverse topics. But one could also design a hypertext/hypermedia document as an ***intensive*** medium with links providing supplemental information to help the user read and understand the original text. We have designed such an intensive hypertext/hypermedia model and used it with children and adults. We call our approach.

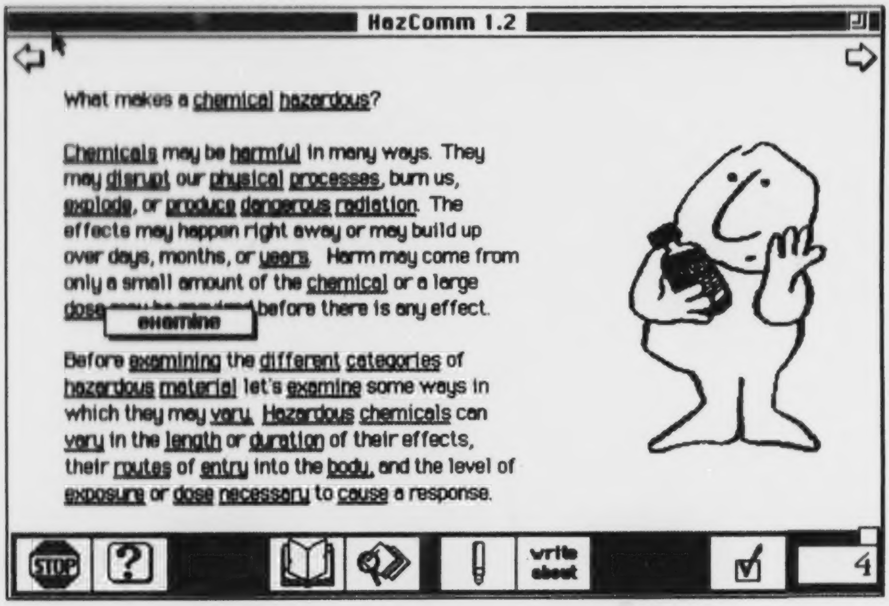
Responsive Text

The responsive text model is based on what we know about the needs of readers. Good readers bring many skills to the reading task and for those with less proficiency, hypermedia support can compensate for their shortcomings. In particular, responsive text offers support in four areas of reading difficulty: decoding, background knowledge, inferencing, and comprehension monitoring. To illustrate how these supports can be implemented we will use sample screens from a responsive text material on handling hazadous materials, part of a lesson designed for use in a Workplace Literacy Demonstration Project funded by the Federal Department of Education.

Decoding

At the most basic level, reading proficiency requires decoding visual representations of words into a phonological representation (Gough & Hillinger, 1980). While poor readers may be able to decode words, their lack of fluency makes the process is difficult and diverts attention from higher level comprehension processes.

To assist decoding, responsive text provides spoken representations of words. Turning on the speech mode, by clicking the speaker icon, underlines the words that can be spoken (see Figure 1). With affixed words only the base word is encoded. Thus, when clicking on ***examining, examine*** is spoken and the uninflected version is displayed in a small window adjacent to the selected word. Having a spoken version of a printed word readily available allows the reader to focus on higher-level comprehension processing. Beyond immediate support, Reitsma (1988) has found this method of providing readers with independent access to spoken and visual representations of words is an effective way to teach decoding.



What makes a chemical hazardous?

Chemicals may be harmful in many ways. They may disrupt our physical processes, burn us, explode, or produce dangerous radiation. The effects may happen right away or may build up over days, months, or years. Harm may come from only a small amount of the chemical or a large dose may be required before there is any effect.

Before examining the different categories of hazardous material let's examine some ways in which they may vary. Hazardous chemicals can vary in the length or duration of their effects, their routes of entry into the body, and the level of exposure or dose necessary to cause a response.

Figure 1. Decoding Support in Responsive Text

Background Knowledge

As Chall (1983) notes, reading beyond the earliest stages requires background knowledge. This knowedge of vocabulary, phrases, and idioms—all gained through reading—is necessary for later reading stages. Poor readers often lack the necessary background knowledge to understand a passage.

In responsive text this support is enabled by turning on background knowledge (an icon adjacent to the speech support button). With background *on*, words having definitions are displayed in bold and selecting the word causes a brief definition to be displayed (Figure 2).

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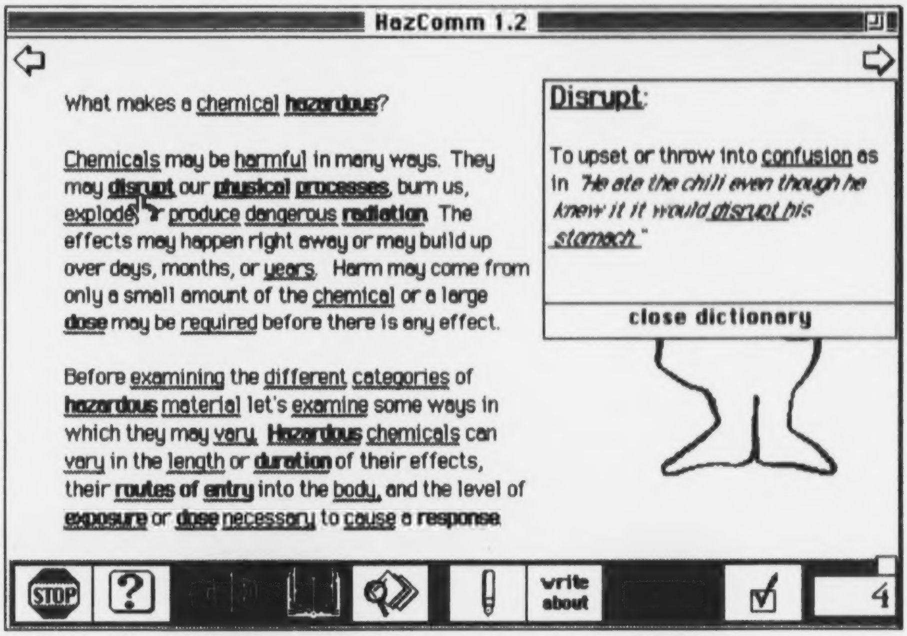

HazComm 1.2

What makes a chemical hazardous?

Chemicals may be harmful in many ways. They may disrupt our physical processes, burn us, explode, or produce dangerous radiation. The effects may happen right away or may build up over days, months, or years. Harm may come from only a small amount of the chemical or a large dose may be required before there is any effect.

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Disrupt:

To upset or throw into confusion as in *"He ate the chili even though he knew it it would disrupt his stomach."*

close dictionary

Figure 2. Background Knowledge Support in Responsive Text

While a short definition is sufficient for many of the words, some words or ceoncepts requires a more extensive definition. When such an item is selected a *more about...* icon that appears. Clicking this button leads to more extensive background information. With the links provided in hypermedia, there is no practical limit to how detailed this background information can be.

Inferential Capacity

Reading requires filling in information not explicitly stated (Collins, Brown, & Larkin, 1980). Poor readers may have difficulty explicating relationships or noting causal sequences. There may also be confusion over the relative importance of ideas, or just too many new words and concepts. In responsive text, passage-level assistance is available through the closeup option. Selecting the closeup option (the magnifying glass icon) reveals the portions of the text that have closeup information available.

Providing passage-level support is more complex than linking definitions and speech to individual words and closeups utilize the full pallette of hypermedia tools. Some learners can make better use visual information and, for them, passages can often be explained with a diagram, animation, or even a video clip. In other cases the text itself can be changed with implicit relationships made explicit and critical words emphasized. Because the learner selects the type of assistance he or she finds most useful, a variety of aids can be added to suit an individual's learning style.

Comprehension monitoring

As readers, we frequently check or monitor what we think we are reading against the information in the text. Baker & Brown (1984) have noted that poor readers often have difficulty monitoring their comprehension of a passage. In responsive text, checkup questions, available at the reader's option, allow the reader to check their passage understanding. Checkup questions can take a variety of forms. In Figure 3 the reader must move parantheses around a sentence containing relevant material. Using the computer's power allows checkup questions to become quite sophisticated—moving switches, testing temperatures, measuring distances— can all be simulated in software. Figure 4 shows how a checkup can check both the factual knowledge of flashpoints and the basic skill of reading a table. Checkup questions are not used for evaluation and no record of performance is maintained. This encourages the reader to try the checkup question repeatedly, going back to earlier parts of the text as needed.

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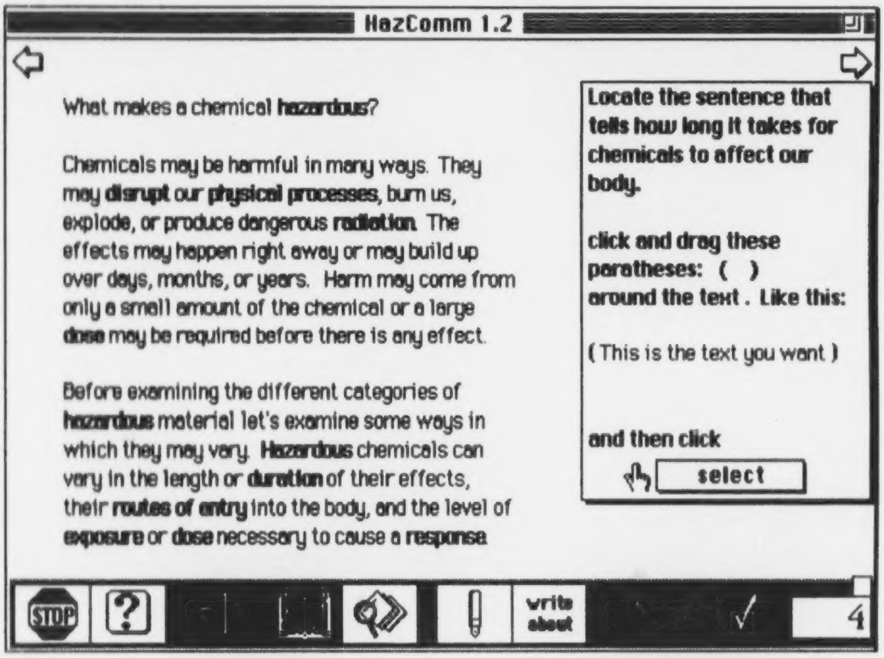

HazComm 1.2
STOP
?
write about
4

What makes a chemical **hazardous**?

Chemicals may be harmful in many ways. They may **disrupt our physical processes**, burn us, explode, or produce dangerous **radiation**. The effects may happen right away or may build up over days, months, or years. Harm may come from only a small amount of the chemical or a large **dose** may be required before there is any effect.

Before examining the different categories of **hazardous** material let's examine some ways in which they may vary. **Hazardous** chemicals can vary in the length or **duration** of their effects, their **routes of entry** into the body, and the level of **exposure** or **dose** necessary to cause a **response**.

Locate the sentence that tells how long it takes for chemicals to affect our body.

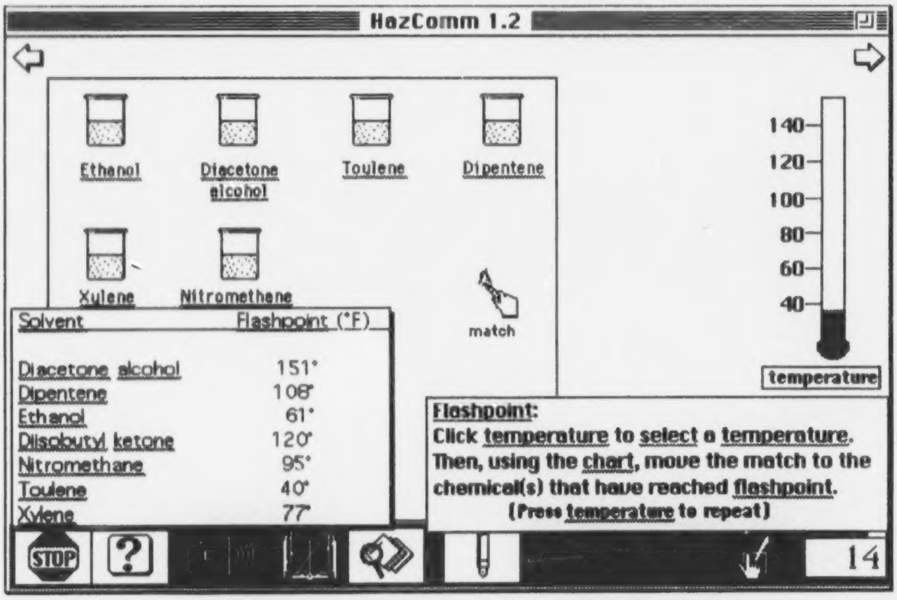
click and drag these paratheses: ( ) around the text . Like this:

(This is the text you want)

and then click

select

Figure 3. Identifiying Information in the Passage


HazComm 1.2
Ethanol
Diacetone alcohol
Toulene
Dipentene
Xylene
Nitromethane
match
140
120
100
80
60
40
temperature
STOP
?
14

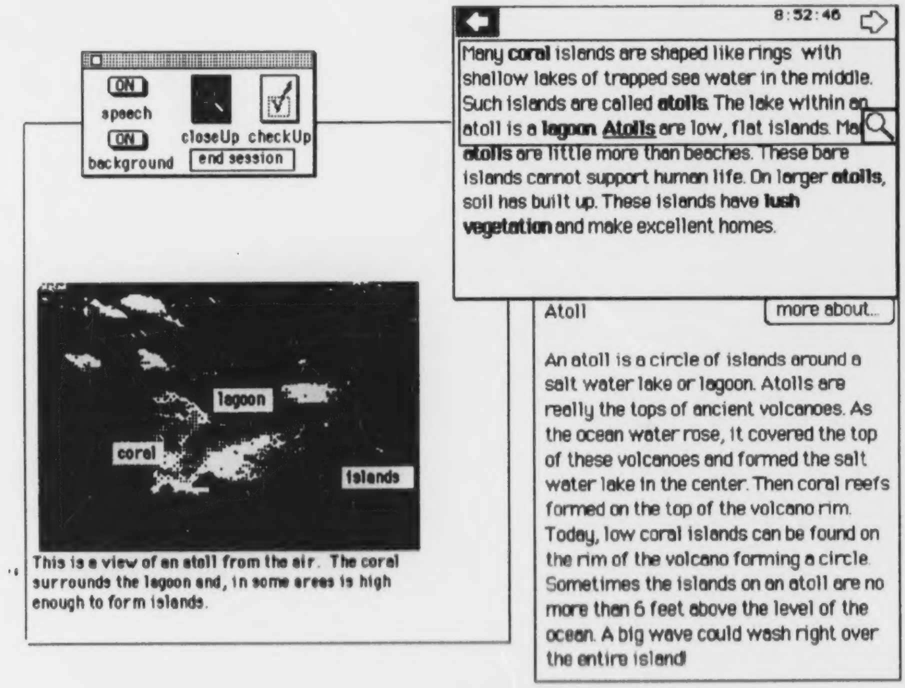
Solvent	Flashpoint (°F)
Diacetone alcohol	151°
Dipentene	108°
Ethanol	61°
Diisobutyl ketone	120°
Nitromethane	95°
Toulene	40°
Xylene	77°

Flashpoint:
Click temperature to select a temperature. Then, using the chart, move the match to the chemical(s) that have reached flashpoint.
(Press temperature to repeat)

Figure 4. Checkup on Flashpoint and Reading Charts

Responsive Text and Content Area Instruction

Responsive text can also be used for younger readers. Chall and Squire (1991), have noted that, for K-12 students, content area texts have been traditionally recognized a difficult to comprehend so we designed another series of responsive text around middle school science and social studies. A sample screen from a lesson on the Pacific Islands is shown in Figure 5. Where the workplace material had to run on Macintsoh SE, the middle school material was able to take advantage of the more powerful Macintosh II platform.



Many **coral** islands are shaped like rings with shallow lakes of trapped sea water in the middle. Such islands are called **atolls**. The lake within an atoll is a **lagoon**. Atolls are low, flat islands. Ma **atolls** are little more than beaches. These bare islands cannot support human life. On larger **atolls**, soil has built up. These islands have **lush vegetation** and make excellent homes.

This is a view of an atoll from the air. The coral surrounds the lagoon and, in some areas is high enough to form islands.

An atoll is a circle of islands around a salt water lake or lagoon. Atolls are really the tops of ancient volcanoes. As the ocean water rose, it covered the top of these volcanoes and formed the salt water lake in the center. Then coral reefs formed on the top of the volcano rim. Today, low coral islands can be found on the rim of the volcano forming a circle. Sometimes the islands on an atoll are no more than 6 feet above the level of the ocean. A big wave could wash right over the entire island!

Figure 5. Sample Social Studies Responsive Text

The middle school material was used in a controlled study of the potential instructional advantages of responsive text over less interactive formats. Leu, Gallo, & Hillinger, (1993) found that students reading the material in responsive text comprehended more than students seeing the material in its original textbook versions or in less interactive computer verisons.

Conclusions

We have been developing and using responsive text materials for almost four years and a number of important points have emerged.

Presenting training material in responsive text blurs the line normally drawn between job skills (e.g., knowing how to handle a hazardous material) and basic skills (knowing how to read instructions). Although we began by designing workplace literacy training that used job-relevant materials, we have evolved in our thinking and now we try to develop job trainings, usable by anyone, that is "basic skills sensitive".

Responsive text allows us to integrate diverse skills into a lesson. While the early versions of responsive text (cf. Hillinger, 1992) focused on literacy, We found that reading expository materials, on the worksite or in the classroom, required a mix of skills including an understanding of charts, interpreting graphs, and even some basic math. Our most recent responsive text materials now include support in reading charts, interpreting graphs, and basic math.

The addition of hypermedia support turns text into a rich information experience. While enhancing the information spectrum should increase the learning potential our research indicates that the learner must also learn how to best exploit

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these new resources. The rich array of support possible within the multidimensional information landscape makes it likely that the strategic knowledge of how to use hypermedia may be even more important than in traditional static text environments.

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Paper (M2-202B)

Designing Hypermedia to Connect Reading and Writing through Children's Literature

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Key words: hypermedia, reading, writing, literature

Abstract

This paper argues that while hypermedia and multimedia contain great promise for supporting literacy learners engaged in reading children's literature, software in this area has generally failed to consider the potential of connecting reading and writing experiences within the same electronic environment; reading and writing software has generally been developed for separate instructional purposes. The paper begins by describing the advantages to using children's literature for supporting literacy development. It then describes the multiple advantages of literacy experiences that connect reading and writing around children's literature: cognitive, analytic, social, and pragmatic. It discusses how a passage from *James and the Giant Peach* was developed as a hypermedia "think piece", allowing us the opportunity to consider how reading and writing connections might be developed that are grounded in research on literacy development within traditional, static texts. It shows how design elements such as E-mail, a reader response journal, and an electronic bulletin board, used within the reading experience, can support literacy learners by connecting reading and writing within a hypermedia context. Examples of written communication from a fourth grade classroom are described to demonstrate the power of this type of design to support children's literacy learning in areas such as comprehension, response, critical thinking, and communication.

Using Children's Literature to Support Literacy Learning

Recent work (Atwell, 1987; Norton, 1990) has demonstrated the powerful potential of children's literature to support literacy learning in school classrooms. Quality children's literature increases the amount of reading that takes place inside and outside of school settings (Anderson, 1990). Equally important, quality children's literature can be used to increase the sophistication and variety of children's responses to text , improve children's developing decoding ability, support the development of vocabulary knowledge, increase children's ability to make central inferences, increase children's understanding of important discourse structures, support the development of metacognitive knowledge, and increase children's ability to think critically (Leu & Kinzer, 1991; Shanahan & Tierney, 1991). It is clear that children's literature contains a powerful potential for supporting literacy learners.

Perhaps because of this powerful potential, children's literature has recently found its way into electronic environments. Multimedia versions of children's literature have recently appeared in such products as Houghton Mifflin's Reading Comprehension Series, Broderbund's "Just Grandma and Me", and the software series by Discus. Clearly, electronic publishers are beginning to recognize the potential of children's literature and the new forms of literary experiences that may be developed within hypertext, multimedia, and hypermedia contexts.

Supporting Literacy Learners by Connecting Reading and Writing

Unfortunately, however, while electronic publishers have recognized the importance of children's literature, they have yet to recognize that literacy educators assign an equal importance to experiences that connect reading and writing. Combining reading and writing experiences for literacy learners is important for many reasons: cognitive, analytic, social, and pragmatic.

Cognitively, it is clear that combining reading and writing experiences results in children who learn to both read and write better (Stotsky, 1983). Because both written language modes rely upon similar and related types of knowledge, learning about reading enhances writing ability and learning about writing enhances reading ability (Tierney & Pearson, 1991; Shanahan, 1990). This special relationship has been referred to by various metaphors such as "two sides of the same mirror" (Smith, 1983) or "two sides of the same coin" (Leu & Kinzer, 1991). In each case the special, reciprocal nature of the reading-writing relationship is recognized. This relationship can be effectively exploited in the classroom to simultaneously support academic development in both areas.

In addition, reading and writing, when combined in classroom experiences, can be used as powerful tools to increase students' ability to analyze and think critically about information. Separately, both reading and writing may be used to develop critical thinking skills but when combined, they serve to reinforce each other and produce even greater benefits than if they are used alone (Tierney and Shanahan, 1991). This is an especially important requirement of citizens who wish to participate fully in an economically and interdependent world (Kirsch & Jungeblut, 1986; Langer, Applebee, Mulis, & Foertsch, 1990; National Commission on Excellence in Education, 1983; Ravitch, 1985; The Secretary's Commission on Achieving Necessary Skills, 1991).

Pragmatically, combining reading and writing experiences is also efficient, a quality whose significance should not be underestimated for busy classroom teachers facing increasing demands on instructional time as states and local units mandate new curricular areas. In addition to increasing learning, linking reading and writing experiences can result in a more efficient use of limited instructional. This pragmatic aspect of connecting reading and writing often is often viewed by teachers as more important than any other (Shanahan, 1990).

Combining reading and writing experiences also says something important to literacy learners about the nature of literacy. Literacy is fundamentally a social and communicative act (Daniels, 1991). Readers attempt to understand the meanings assigned by writers and writers attempt to anticipate the meanings assigned by readers (Tierney, 1991). Viewing literacy from this social communications stance is something that is well known to mature readers and writers. Providing separate experiences for reading and writing increases the chance that literacy learners will miss this fundamental aspect about the nature of literacy. As a result, they may be less likely to use literacy in their own lives or to use it less effectively when they do read and write.

Taken together, combining reading and writing creates a powerful context for literacy learners as they simultaneously develop important academic skills, hone the ability to think critically about important issues, meet increasing the content area requirements demanded by our society, and acquire insight about literacy as a social and communicative act. It is surprising, therefore, that publishers who design electronic contexts for learning have generally failed to provide opportunities for literacy learners to engage simultaneously in reading and writing experiences. While the recent cycle of software from school publishers contains both reading and writing within the same CD-ROM environment (e.g., Scholastic's Smart Books or Houghton Mifflin's The Media Experience) they provide reading tasks and writing tasks as separate experiences and, as a result, fail to capture the potential of simultaneous experiences with these two reciprocal modalities of literacy.

The purpose of this paper is to consider how reading and writing might be more effectively integrated within the same literacy experience as children engage in an experience with children's literature. It will present one design possibility for integrating reading, writing, and children's literature; a design that was developed not as a commercial product, but rather as a "think piece" to explore how the potential of combining reading and writing experiences might best be utilized within the dynamic electronic environment that is possible in hypermedia. It will then show how children in a fourth grade class used this software to support their own literacy learning.

Connecting Reading, Writing, and Children's Literature within Hypermedia

As we developed this "think piece", three considerations regularly came up in our conversations: we needed to use a quality work from children's literature, we needed to design support structures that would meet the reading needs of a variety of students, and we needed to design structures that would connect reading and writing in a manner that would exploit the cognitive, pragmatic, social, and analytic potentials of this connection.

Selecting Children's Literature

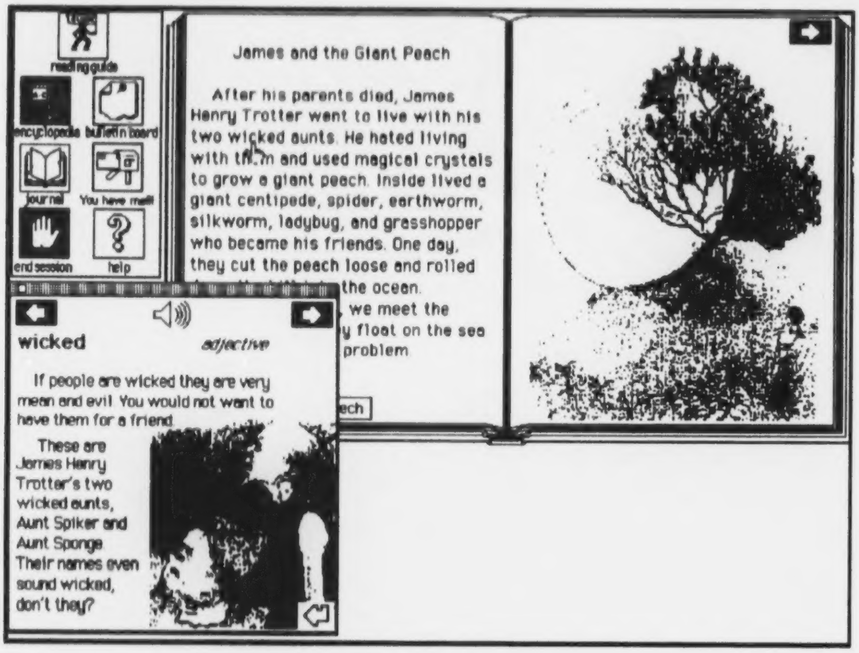
The literature selection we ultimately decided to use in this project consisted of a chapter from *James and the Giant Peach* by Roald Dahl. This fantasy describes the adventures of an English boy, James, and a collection of insect friends who travel across the Atlantic on a giant peach to the U.S. The author is widely recognized for his exceptional fiction and is popular among many fourth grade students. The book we selected is commonly recommended by textbooks on children's literature (Norton, 1991; Sutherland & Arbuthnot, 1991).

We decided to use a short set of chapters rather than the entire book and then encourage students to check the book out from their library if they wanted to see how the story ended. The chapters we used describe how the adventurers learn that a school of sharks is eating their peach and how they discover a way to save themselves.

Designing Support Structures to Meet the Reading Needs of a Variety of Students

In order to determine the types of support structures to include for readers, we relied largely on cognitive and information processing models of reading (cf. Anderson & Pearson, 1984; Just & Carpenter, 1987). These led us to develop support structures in four areas important for comprehension: decoding, vocabulary, metacognition, and inferential reasoning.

Decoding and vocabulary support were provided simultaneously for words that we determined to be more challenging for students. These words were appeared in boldface in the text to make them visible to students. Clicking on any of these words would provide the pronunciation with digitized speech, and then open up a window providing a brief definition, the part of speech, and a description elaborating on the meaning of this word within the context of the story. This description often went on for several additional windows. An example of these features can be seen in Figure 1.



James and the Giant Peach

After his parents died, James Henry Trotter went to live with his two wicked aunts. He hated living with them and used magical crystals to grow a giant peach. Inside lived a giant centipede, spider, earthworm, silkworm, ladybug, and grasshopper who became his friends. One day, they cut the peach loose and rolled
the ocean.
, we meet the
y float on the sea
problem

ech

wicked *adjective*

If people are wicked they are very mean and evil. You would not want to have them for a friend.

These are James Henry Trotter's two wicked aunts, Aunt Spiker and Aunt Sponge. Their names even sound wicked, don't they?

Figure 1. An illustration of decoding and vocabulary support available during the reading of the story.

There is nothing especially unusual about the nature of our decoding and vocabulary support for readers. These types of support structures are often found in reading software. Metacognitive and inferential support, however, are not often found. Metacognitive support refers to supporting strategic knowledge demands placed on readers within dynamic, interactive environments. Knowing how to navigate within hypermedia, for example, is often a problem (Bernstein, 1991; Gay and Mazur). We tried to overcome this problem by providing students with the option of using a "Reading Guide". If students were unfamiliar with the system, they could select this feature. Doing so, opened up a new window and the system took them through a guided reading of the excerpt, explaining how each support structure worked at moments when it was most appropriate. An example of a window from a "Reading Guide" can be seen in Figure 2.

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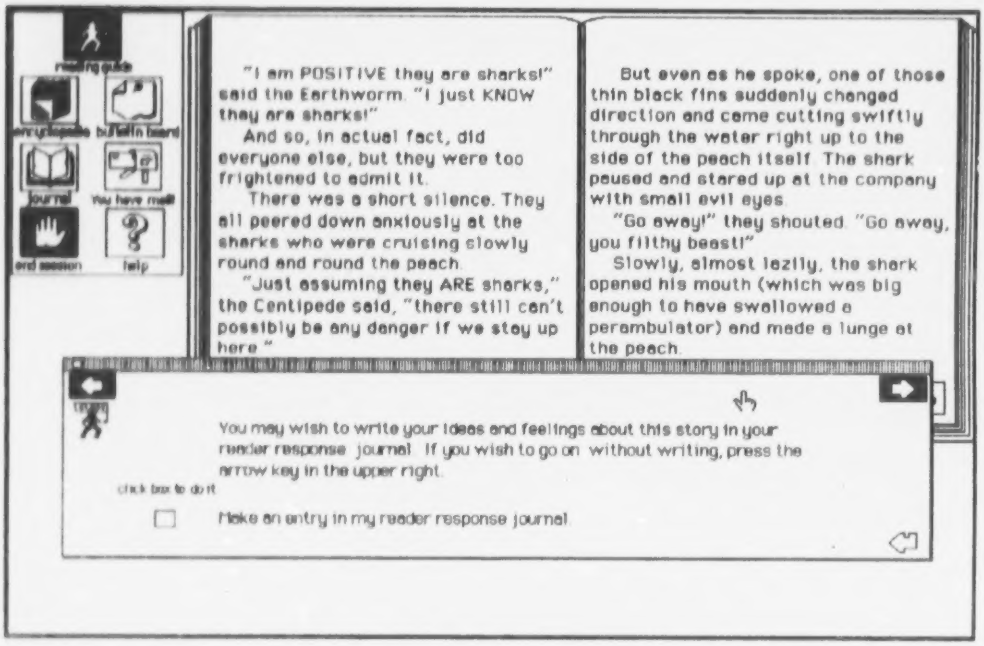


"I am POSITIVE they are sharks!" said the Earthworm. "I just KNOW they are sharks!"

And so, in actual fact, did everyone else, but they were too frightened to admit it.

There was a short silence. They all peered down anxiously at the sharks who were cruising slowly round and round the peach.

"Just assuming they ARE sharks," the Centipede said, "there still can't possibly be any danger if we stay up here."

But even as he spoke, one of those thin black fins suddenly changed direction and came cutting swiftly through the water right up to the side of the peach itself. The shark paused and stared up at the company with small evil eyes.

"Go away!" they shouted. "Go away, you filthy beast!"

Slowly, almost lazily, the shark opened his mouth (which was big enough to have swallowed a perambulator) and made a lunge at the peach.

You may wish to write your ideas and feelings about this story in your reader response journal. If you wish to go on without writing, press the arrow key in the upper right.

☐ Make an entry in my reader response journal.

Figure 2. An illustration of the "Reader's Guide" providing metacognitive support.

During this guided reading of the story, support for inferential comprehension of the passage was also provided at three locations. This was done by using a levels approach to designing comprehension questions (Leu & Kinzer, 1991). Our goal was to teach inferential processes, not simply to test inferential comprehension. We did this in three ways. First, incorrect responses to inferential questions were followed by dropping back to a literal level question, directing students to a central piece of information required in the inference. Second, after students responded to this literal level question, the central, literal information was highlighted in the text. This increased the chance they would see and make connections with this information. After students responded to this literal level question, the inferential question was again presented. We believed that drawing children's attention to central, literal information would support them in later making the correct inference. Third, following the complete sequence of responses, students received an explanation of how the inference was derived. This included both a verbal explanation and the highlighting of the appropriate information in the text. Teaching strategies for inferential reasoning and modeling these strategies is something that has not previously been included in software design.

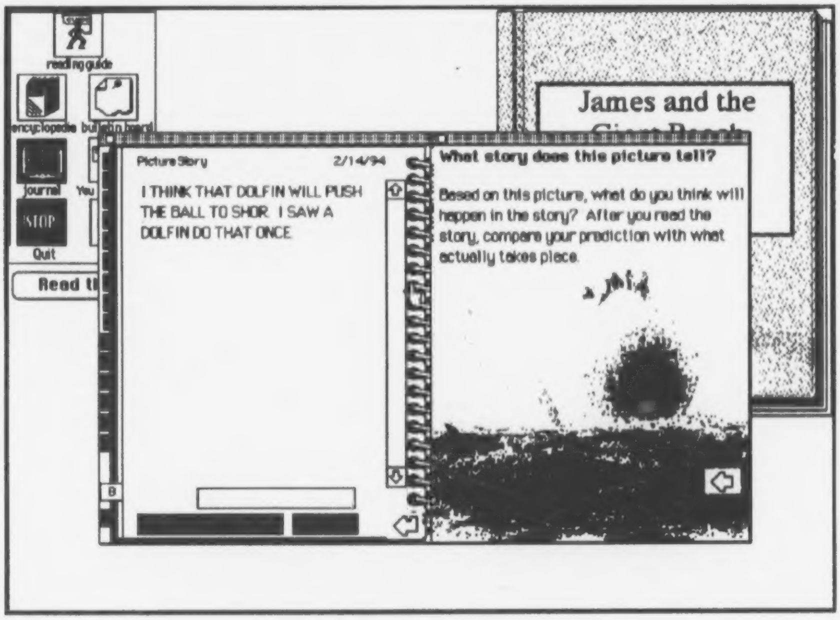
Designing Structures to Connect Reading and Writing

As we considered ways in which to make connections between reading and writing within this environment we were guided by previous work suggesting it was important to exploit the cognitive, analytic, social, and pragmatic potentials of this environment. This led us to build several features into the design that would connect reading and writing experiences around a social-communication model and simultaneously exploit these potentials. Three design features emerged from our conversations: a reader response journal, a classroom bulletin board, and an electronic mail system.

Using a reader response journal to exploit cognitive and analytic potentials

A central aspect of our attempts to connect reading and writing was to build into the design a reader response journal. Reader response journals are often used by teachers to connect reading and writing in classrooms (Nathan & Temple, 1991). As students read a work of literature, they are encouraged to enter their thoughts and reactions to what they are reading in their journal. This allows students to draw insights useful to their cognitive development and to engage in opportunities to think critically about information they are reading.

To support students' responses in their journals, we also included a set of potential writing ideas that students could access during their reading of the story. At each location in the passage, students selecting this support option would be presented with a list of writing ideas that were appropriate for that location. Figure 3 illustrates one student's entry in her reader response journal in response to a writing prompt.



Picture Story 2/14/94

I THINK THAT DOLFIN WILL PUSH THE BALL TO SHOR. I SAW A DOLFIN DO THAT ONCE

What story does this picture tell?

Based on this picture, what do you think will happen in the story? After you read the story, compare your prediction with what actually takes place.

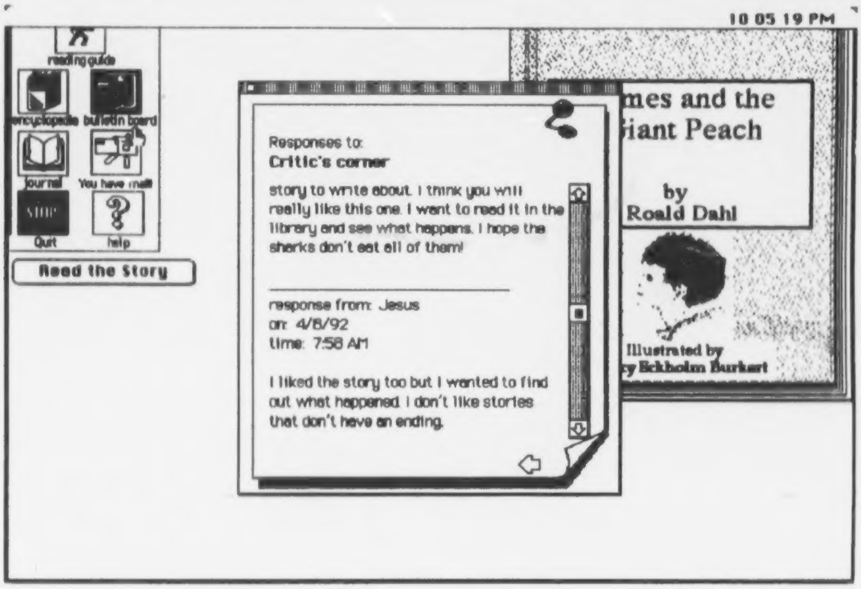
Figure 3. An illustration of a student making an entry in their reader response journal.

Using a classroom bulletin board and E-mail to exploit social potentials

Reading and writing connections should not only be made for cognitive and analytic purposes, however. It is also important to provide functional communication opportunities for students so they might understand through their reading and writing that these are fundamentally social processes. When students view reading and writing as social process they, in turn, are more likely to acquire cognitive and analytic abilities that are central to literacy proficiency (Shanahan, 1991). To accomplish these purposes, we included two types of support features into our design: a classroom bulletin board and an E-mail system.

After students had made an entry in their reader response journal, they could, of course, keep it to themselves in their journal. In addition, however, they could also send it to the classroom bulletin board to be read by others. This would lead students to developing recursive chains of reading-writing connections as one student would read the text and write a response, sending it to the bulletin board. This would be followed by another student reading the message and then writing a response to the initial posting on the bulletin board from their own reader response journal. This would be followed by still other students reading and responding in turn. An example of these written "conversations" in a bulletin board location can be seen in Figure 4.

In addition to exploiting the social potential of connecting reading and writing through an electronic classroom bulletin board, we also developed an E-mail system so that students could send confidential messages to one another about their reading experiences and other issues of personal concern. This was accomplished by opening up their reader response journal and sending an entry to another student in the class. Students received their mail in their personal "mailbox". Figure 5 provides an example of this second social feature.


10 05 19 PM
reading guide
encyclopedia
bulletin board
journal
You have mail!
STOP
Quit
help
Read the Story
James and the
Giant Peach
by
Roald Dahl
Illustrated by
Nancy Ekholm Burkert

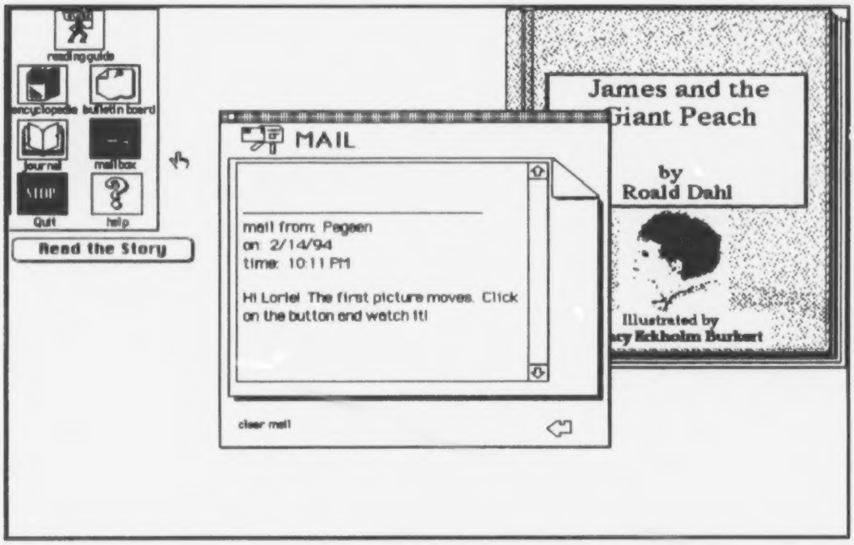
Responses to:
Critic's corner

story to write about. I think you will really like this one. I want to read it in the library and see what happens. I hope the sharks don't eat all of them!

response from: Jesus
on: 4/8/92
time: 7:58 AM

I liked the story too but I wanted to find out what happened. I don't like stories that don't have an ending.

Figure 4. An illustration of a written "conversation" in the classroom bulletin board.


reading guide
encyclopedia
bulletin board
journal
mailbox
STOP
Quit
help
Read the Story
MAIL
clear mail
James and the
Giant Peach
by
Roald Dahl
Illustrated by
Nancy Ekholm Burkert

mail from: Pegeen
on: 2/14/94
time: 10:11 PM

Hi Lorie! The first picture moves. Click on the button and watch it!

Figure 5. An example of a student receiving an E-mail message from a friend.

Connecting Reading and Writing in Hypermedia to Exploit Pragmatic Potentials

Developing this "think piece" makes it clear that multiple curricular aims may be accomplish simultaneously within software that is thoughtfully designed. This will be true, however, only if software developers pay greater attention to the instructional needs of teachers. So much of the software we have seen after working on this project appears, to us at least, to be technically sophisticated but instructionally out of touch with the curricular needs of teachers. Indeed, this may account for the fact that while prevalent in schools, software and other technology is not always used with great frequency (Becker, 1990; Congressional Office of Technology Assessment, 1988; Martinez & Mead, 1988; Reinking & Bridwell-Bowles, 1991). The pragmatic potentials of any design will only be fulfilled if that design is based on the curricular needs of teachers and students.

This observation is also related to a final point that emerged from our work on this project. As we watched this "think piece" being used in a fourth grade classroom it struck us that the design we used, based on the communicative potentials that appear when one connects reading and writing experiences, might best be described as generative hypermedia. Students, in their "written conversations", E-mail messages, bulletin board entries, and response journal entries were actually adding new pathways within the initial environment we had constructed. In a very real sense they were generating a new hypermedia environment by the nature of their joint interactions with the text. It may be that the generative potential we discovered in this work is the most important advantage to connecting reading and writing within hypermedia. It is through generating a new environment that students and teachers are able to adapt any initial design to meet their particular needs. As a result, it is likely that "generative" designs will more often be brought into classrooms for instructional purposes.

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Project (M2-203A)

The Global Education Telecommunications Network—Criteria for Successful E-Mail Projects

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Key words: telecommunications projects, authentic learning, GETN, E-mail, international education, multicultural projects

Abstract

The Global Education Telecommunications Network (**GETN**) Project involves teachers and their students around the world in inquiry-based electronic mail (E-mail) projects. Students are sharing concerns about global issues, learning about other cultures, and using technology that will be as commonplace in the future as the telephone is today. This session will examine how E-mail projects become an important motivating force across the curriculum, how teachers are transforming what and how they teach, and how these international projects help to replace workbook and textbook exercises with authentic work that is shared with students around the globe.

Five years ago the School of Education of the City College of New York developed the idea for an electronic mail network that would link primary and secondary schools in New York with their counterparts in London. Today our **GETN** project links more than 50 schools in New York with schools in fifteen different countries. Our network is centered around inquiry-based projects developed by teachers who are introduced to one another through the network. Teachers are not provided with predesigned projects that they complete with their classes. Instead, they negotiate with one another and identify ideas for projects that will best meet the needs of their students and fulfill their responsibilities to their curriculum.

City College not only created **GETN**, it continues to provide the ongoing support so important in sustaining **GETN**'s network and helping it to grow. Support is provided in a variety of ways including: courses for participating teachers, on-site technical training, on-line managing and monitoring of projects, recruiting new participants and sponsoring annual conferences.

As the project developed, we have come to realize its potential for improving teaching and learning in the New York City Public Schools. Giving teachers the opportunity to design their own activities spawns enormous creativity and has led to the creation of many innovative and exciting projects. These projects, in turn, help to transform often dull and lifeless classrooms into places where children are actively engaged in authentic work that they own and could share with their partners abroad. While individual projects are important for **GETN**'s success, even more important is what teachers are learning as a result of participating in the network and in the graduate courses that support the network. We developed our own education rationale for E-mail projects which has become embodied in a set of criteria for the design of **GETN** projects.

Teachers report that our project is exciting and motivating for students, especially in the primary grades. They help to engage learners who have been disinterested in school by providing the occasion for real, meaningful work that are owned by students and can be shared with others. We are also curious about the extent to which **GETN** projects promote a change in teachers' assumptions about teaching and learning as well as changes in curriculum and instruction. We are currently investigating these questions and hope to share some data at NECC '94.

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Project (M2-203B)

Telecommunications Across The Country: You Too Can Do It!

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Key words: telecommunications, beginner, elementary, help, introduction

Abstract

The presenters met, through a mutual friend, at NECC'92 in Dallas. After attending several telecommunications presentations while in Dallas, they began talking about trying to attempt a telecommunications project with their respective fifth grade classes. Both teachers had just purchased modems and had no experience with telecommunications. They felt ready to tackle this new learning experience during the 1992-93 school year.

The schools where they teach are very different. Fred teaches computer at a public Technology Magnet School in a deprived area in Tacoma, Washington. Cheryl teaches science at an independent school in Pittsburgh, Pennsylvania. The settings of their schools are also very different. McCarver Elementary School is on Puget Sound with the Cascade Mountains in the background. Shady Side Academy is located on the outskirts of Pittsburgh; so the setting is urban.

They decided to begin their project early in the second semester. They quickly realized that it was not going to be as easy as the presenters in Dallas had made it seem. Several weeks went by while Fred worked on getting permission from his Superintendent to make out of town phone calls. He also had to get a special code number. Cheryl was pioneering telecommunications at her school so she had no one to go to for help. During the next two months, these teachers encountered many problems. Most of them were solved by trial and error and none of them discouraged either of these teachers. In fact, when they finally connected for the very first time, it was a wonderful feeling of accomplishment for both of them.

The result of this frustration was: Cheryl and Fred learned a lot about beginning a telecommunications project. They kept careful notes as they went along and now would like to offer help, support and encouragement for teachers who would like to start a project but have no idea how to begin. We'll begin at the beginning and answer all questions that participants may have been too embarrassed to ask at another session. There are no dumb questions at this Project session!

They will share the activities they implemented throughout this project and a complete hand-out will be given to participants. If possible, they'll actually telecommunicate with a teacher in Pittsburgh. The participants will then be able to watch as a computer is set to telecommunicate and a file is sent and received.

Project (M2-204A)

Designing MicroWorlds

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Key words: software design, Logo, LogoWriter, MicroWorlds

Abstract

In July 1993, LCSI released *MicroWorlds*. It's a new version of the Logo language built into an environment that has music, animation, drawing tools and lots more. This talk will be about it's design, the kinds of decisions that we had to make, and the kind of thinking and spirit that went into it.

MicroWorlds is a descendant of LogoWriter. It's a descendant in the sense that the goals were about the same. But while the goals were the same the results are decidedly different. *MicroWorlds* is several years younger and these years provided us with lots of chances to see kids using LogoWriter and with computers that were much more capable.

The overall design goal of *MicroWorlds* was to make a constructionist computer environment for kids to use in school. "Constructionism" is a word coined by Seymour Papert as a bit of a pun on constructivism. While constructivism says that kids learn by building their own knowledge, constructionism adds that they can more easily build their own knowledge while building artifacts that are meaningful to them. What follows from this is our trying to make software and books that encourage kids to work on projects that are usually very open ended and long term. Our materials can only do this if they provide some structure and direction. However they must do this in a way that appear unstructured and non- directive.

This kind of design leads to a number of different tensions, sometimes about details sometimes about big issues. An example of a detail was the decision to go with multi colored shapes. This clearly is an improvement to the shapes we had in LogoWriter. At the same time it meant giving up the very concrete effect of having the turtle's color be the same as the pen's color. While this particular issue isn't very important by itself, it points to the tension between compatibility with what people are used to and the desire to add enhancements.

An example of a bigger issue was the decision to add drawing tools. We felt that it's better to allow kids to do easy things in easy ways. However, we know that this sort of addition is controversial. Some people will argue that the power of Logo, or that the point of Logo was to incite kids to program. Making it possible to draw a square with a mouse driven square-drawer tools, they would say, distances kids from the desire to program. We obviously don't agree. We feel that there's no point making something harder than it need be just to force the need to program. There's enough reason in *MicroWorlds* to program anyway, (to animate, for instance) that it seems unreasonable to insist that someone program something that many applications let you do directly.

These issues and dozens more like were central in the design of *MicroWorlds*. We didn't try to settle all these issues by ourselves. Instead we benefited from the experience of a group of external consultants that included teachers who had extensively used Logo and researchers from several universities. Papert was also a very important contributor to the design. We also didn't try to do the design in a vacuum. There was an extensive series of field tests of different prototypes in many schools in many cities. Some of these prototypes will be demonstrated during this session.

Design is about making choices. And usually after the choices are made the scaffolding is neatly erased and only the taken path remains. This session will describe the process that led to these choices and to try and provide some insight into why what was done was done and why what wasn't wasn't.

Project (M2-204B)

An Overview of the Logo Foundation

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Key words: Logo, professional development, teacher education

Abstract

The Logo Foundation is a nonprofit corporation founded in 1991 with a mandate to support educational uses of Logo worldwide. Initial funding was provided by two of the world's leading Logo software developers, Logo Computer Systems, Inc. of Montreal, and Logo Japan, Inc. of Tokyo. They stipulated that the organization was to be established in the United States, where much of our early activity has been concentrated. The scope of our work is increasingly international, and the sources of funding are becoming broader.

The Logo Foundation

- disseminates information about Logo.
- offers professional development services.
- distributes publications pertaining to Logo theory and practice.

Public Information

Information about Logo is provided in response to inquiries by telephone, mail and E-mail. The most frequent requests are for sources of software and support materials, and about availability of courses and workshops. We publish "Logo Sources and Resources", a list of software companies and publishers offering Logo and related materials, Logo Users Groups and other support organizations, and a brief bibliography of Logo books. "Why Use Logo?", published by Terrapin Software and also distributed by the Logo Foundation, offers an overview of Logo for people who are not familiar with it. Both of these publications are free.

"Logo Update" is the newsletter of the Logo Foundation. It is published three times a year. Subscriptions are free upon request. Each issue includes news about new products, workshops, and conferences. There are several regular columns: "By Seymour Papert", Carol Sperry's book review, the "Logo Tool Box", and "Putting Ideas Into Action" a column reporting on successful classroom and district Logo projects. Each issue focuses on a theme, such as "What is Advanced Logo?", or "Is Programming a Good Activity for Children?".

Publications

The Logo Foundation publishes and distributes books, research summaries, project reports, Logo tools, professional development and informational video tapes, and papers of interest to Logo Users. These include both the Foundation's documents and materials from other publishers. The Foundation's own publications are generally sold with permission to make additional copies for educational uses. This policy is designed to encourage the widest possible distribution at low cost.

In cooperation with local organizations we are establishing international distribution centers for Logo Foundation publications. This will increase worldwide availability of these publications while reducing shipping costs. At the present time, Monash University in Australia, the Omar Dengo Foundation in Costa Rica, the IBM Latin American Education Research Center in Mexico, and BeJa-Logo in Brazil are distribution centers for Logo Foundation documents.

Some Logo Foundation publications, including "Logo Update", are also available via anonymous FTP from a file server at MIT, cherupakha.media.mit.edu (Internet address 18.85.0.47). Postings include both ASCII and Post Script documents.

Professional Development Activities

The Logo Foundation conducts comprehensive professional development programs in a few districts; The St. Paul Logo Project, New York City Community School District 3, and The Caldwell—West Caldwell Public Schools in New Jersey. These projects involve intensive Logo Summer Institutes and follow-up workshops during the school year.

In Costa Rica, we are participating in the Omar Dengo Foundation's project with the Inter-American Development Bank to develop Logo curriculum materials and provide professional development for teachers to enable them to use these materials.

In addition to these long-term, ongoing projects, there are shorter workshops arranged with schools and districts, or conducted at conferences.

The Foundation works jointly with other groups to organize and publicize Logo Conferences. These include the VI Congreso Logo held in Caracas, Venezuela in September, 1993, and Logosium, hosted by the MIT Media Lab prior to NECC '94 in Boston .

The Foundation publicizes and helps organize the meetings of the New York Logo Users Group and provides other Users Groups with assistance in getting started and advertising their activities. Several Logo seminars have been offered as extensions of the Users Groups.

Society Session (M2-206A)

EDUCOM's Learning Initiative

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Key words: higher education, teaching, learning, productivity, collaboration, information technology

Abstract

The educational community, like the public, is worried about the spiraling price of education and the value it delivers. Most recently, for example, the Wingspread Group concluded that America "needs an affordable cost-effective educational enterprise offering life-long learning." But missing from the Wingspread report and from other manifestations of a growing reform effort, such as those supported by the Pew Charitable Trust, is a serious engagement of the instructional flexibilities enabled by the Internet and the aural/visual interactive technologies of the computer. Educational reform is not likely to succeed unless it incorporates a transforming understanding of how the maturing Internet and other telecommunications technologies mitigate the constraints of time and place while providing a collaborative, affordable medium for sharing and communicating—a new medium that begs a re-examination of current teaching and learning practices.

Meanwhile, organizations and businesses vested in instruction are wrestling independently with the implications of the Internet, the evolving national information infrastructure (NII), and the ever increasing functionality available in interactive technologies at increasingly affordable prices. Educational institutions, textbook publishers, disciplinary societies, testing organizations, foundations, and various federal and state agencies see change on the horizon, while hardware/software and telecommunications companies see new markets.

EDUCOM is a non-profit consortium of approximately 600 colleges and universities and 100 corporate associates dedicated to "transforming education through information technology." Drawing on its seminal experience in advancing the Internet/NII agenda, EDUCOM sees an opportunity to facilitate the development of a national learning infrastructure from the resources and expertise of these diverse interests.

The United States has an extraordinary research infrastructure comprised of disciplinary societies, the Internet, publishers of scholarly journals, national laboratories, and peer review. Each of these adds value to leverage, promulgate, and evaluate the work of the university and industrial research community. Underlying each of the value adders is an extensive system of standards and protocols. Increasingly, research is freed from the constraints of place and time and has become a shared, collaborative venture.

The lack of a national learning infrastructure stands in stark comparison.

The United States lacks the infrastructure to facilitate technology-mediated learning and to sustain educational innovation. As in the research venue, this would require the equivalent of value adders to create standards and protocols. It would require collaboration of institutions of learning, disciplinary societies, scholarly publishers, testing services, and the panoply of communications service providers. The goal of such a collaboration would be to create a national learning infrastructure that enables increased educational effectiveness (quality of learning) and efficiency (ratio of result to cost.)

The Internet scales and diffuses precisely because it is based on collaboratively defined practices and protocols for digital transport and interconnectivity. These precompetitive practices and protocols, because they have the force of an extended community, have catalyzed successful commercial products that add value to the Internet and that are accelerating its growth. Precompetitive collaboration can build a core architectural foundation that will seed new commercial markets for competitive digital technologies and learning applications.

EDUCOM will call upon institutions, organizations, and companies to participate in the Initiative by:

- endorsing the goals of the initiative,
- developing and exchanging ideas in a program of collaborative advocacy,

- developing and testing scalable prototypes that demonstrate the feasibility of the goal and lay the foundation for a National Learning Infrastructure.

Revolutionary Classroom (M2-207A)

United States Culture: Informed Students in the Information Age

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Key words: interdisciplinary, integrated, hypermedia, history, literature, computer technology

Abstract

The United States Culture (USC) program is designed to provide an alternative program for juniors at Sheldon High School in Eugene, Oregon to complete the required credits for United States history and literature. This program integrates the study of United States history, literature and technology. Hypermedia based resources provide an alternative to traditional library materials. In addition, students use these hypermedia tools to create and present their own research materials. Flexible scheduling of class time allows a wide range of activities from small seminars to large group discussions and simulations. The teaching team plans the activities to provide a broad base of information that is viewed from as many perspectives as possible. Students are encouraged to provide support to one another and are often given the responsibility of informing classmates about new concepts. The role of student and teacher often interchange as the program unfolds. Teachers and students work together to gain valuable insights into the evolution of today's society in the United States. It is hoped that through this study all members of the group will become better citizens in their own world. Students, teachers, and parents all feel this unusual program offers many exciting advantages for student learning.

Revolutionary Classrooms (M2-207B)

Classroom Kaleidoscope: Paradigms and Pedagogy

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Key words: interactive, multimedia, interdisciplinary, HyperCard, secondary, english, music

Abstract

The educational war is being fought on four fronts: visual, auditory, pattern recognition, and concept/content. If educators don't address these multiple literacies and learning styles, students will change their mental remote control channels faster than you can say MTV.

As a character in *A Separate Peace*, one of the novels my senior English classes read, puts it, "Everything has to evolve- or else it perishes... " (Knowles 87). Rethinking and renewing my approach has become my priority as I struggle to revitalize curriculum by integrating state of the art technology into the instructional program. Simply repackaging traditional pedagogy isn't sufficient; the challenge is restructuring the learning experience in signal-rich paradigms. As a colonel in the educational revolution, I have dual orders; I must both fight for the cause and supply my own horse by creatively seeking funds to purchase equipment. High visibility projects which generate enthusiasm and equipment moneys have enabled me to begin revolutionizing my classroom pedagogy. In this anecdotal presentation excerpts from 7 current and past classroom projects will be demonstrated and discussed. Student-made videos of the construction processes will be viewed. These

presentations have been developed on a Macintosh *HyperCard* platform (though other delivery systems such as LinkWay could be used) to allow integrating video, animation, sound, visual images and associated text.

Project Descriptions:

Long-Island Past, Present and Future: A Living Landscape—Non college bound grade 11 students study Walt Whitman's life and poetry through videotaping and participating in a local museum's presentation about the poet. They learn research techniques by interviewing and videotaping successful local businessmen who hadn't attended college. They experience their multifaceted local literary and historical legacy and are afforded positive role models and viable employment opportunities.

To Thine Own Self Be True or *The Making of Staci's Funky Interactive Multimedia Hamlet Type Thing With Music*—Student/teacher teams collaborate with outside consultants to create/design an interactive multimedia representation of the dilemma Hamlet's expressed in his "To Be Or Not To Be… " soliloquy. The goal becomes to use as many forms of modern interactive technology as possible (laserdisc, video, sound & animation) to illustrate this timeless question. Critical thinking interpersonal communication and socialization skills are emphasized, and art and music appreciation are stimulated as students organize thoughts into text, graphics, video and sound format to create interactive multimedia products.

The Cat Came Back: An Interdisciplinary Cross Grade Interactive HyperCard Collaborative Story Writing Project—A computer LCD is connected to an overhead projector, and the students see and hear a hyperstack of animated pictures & sounds describing a cat's adventures as he/she wanders outdoors and finally finds his/her way home. High school and fourth grade students collaboratively write stories about the cat which are typed and recorded into the HyperStack as they work. Later, the high school writing coaches publish the fourth graders' stories and send them to them.

The 21st Century Term Paper: It's Electric!—The English Department Chairperson, a teacher of English, the Library Media Specialist and students in a senior English honors class endowed with a small grant and equipment moneys from their school district, collaborate to prepare a 21st century electronic research paper. "Paper" is a misnomer–all information gathering and presentation eliminate the use of paper whenever possible.

All About Animal Farm—The librarian and their English and Social Studies teachers assist Grade 9 students groups learning CD ROM, on line searching, OPAC (on line public access catalogue) and electronic search strategies as they electronically research and present interactive multimedia demonstrations of *Animal Farm* as fable, fairy tale, and allegory. Projects also demonstrate similarities between the novel's plot and the events of Soviet Revolution.

Out of Africa—English and Social Studies teachers challenge students to enlighten their peers about the Dark Continent as they create oral and written multimedia research projects for credit in both subjects. Making choices about the delivery/presentation formats or paths to follow while accessing data gives learners a sense of ownership of their projects and provides a human dimension for problem solving. Lively presentation formats present sophisticated concepts to the audience.

A Summer Sampler—Two English teachers help students explore nuances of language from Grade 11 summer reading selections through music, audio and pictures. Bibliographies of these Hyperstacks include videotapes in which the student authors explain their design concepts.

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Special Session (M2-304A)

Setting a Research and Planning Agenda in Modeling and Simulation, K-12

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Key words: modeling, simulation, mathematics, science, networking, teleconferencing

Abstract

Computer modeling and simulation can dramatically enliven mathematics and science education. These have unique capabilities for engaging students in active investigation and can provide compelling learning experiences that enhance insight and understanding. Computational facilities once limited to the research community are becoming increasingly available for use in pre- college education. These include networking and teleconferencing, object-based modeling, hypermodeling, parallel modeling, computer visualization, and virtual reality environments. However, there is a significant lag between the new technological capabilities and their effective educational implementation. This panel will address the question: what research issues need to be considered in bringing computer modeling into the K-12 mathematics curriculum?

Body

The panel derives from a February 1994 workshop on computer modeling and simulation in education as a joint project of Lesley College and BBN Systems and Technologies under the support of the National Science Foundation. The purpose of the workshop was to develop a coherent framework for guiding research and development and advancing the application of appropriate technology. Participants included curriculum and software developers, teachers, scientists and mathematicians, educational researchers, and experts in computer simulation and modeling. Their presentations demonstrated an abundance of modeling ideas and applications and showed the richness and diversity of educational modeling applications made possible by current technology.

Workshop discussions centered on several technological and pedagogical issues that were viewed as key and central for guiding educational modeling research. These include the relationship between the modeling methods and tools used in research and those used for modeling in education, the relationship between computer-based modeling activities and real-world observation and experimentation, the relationship between learning to use models and learning to design and build models, and the relationship between computer visualization of a model's output behavior and computer visualization of a model's structure and component processes as it runs. Participants had diverse views on these issues. They agreed to develop in-depth case studies of representative examples of some of the best educational modeling work to provide a concrete source of reference material for illustrating and illuminating their views on the issues. The studies will be published in a special issue of the research journal, *Interactive Learning Environments*. A large part of this session will be devoted to audience comments and questions.

Distance Learning (M2-306A)

Artist in Electronic Residence

Chris Viegaard

Participate in the following live broadcast

Mime

Trent and Melodie Hicks Arterberry return to the Mass LearnPike!

Students will work with these masters and enjoy expressing themselves through mime and movement. Each session will focus on an aspect of mime, such as illusions, characterization, improvisation, and makeup. Participants will develop an appreciation for the self-discipline and control involved in this art form.

Artists

Trent Arterberry began the study of mime in the 1970s with teachers such as the famed Marcel Marceau. In 1979, he debuted his full-evening, one-man production for a critically acclaimed, month-long run at Boston's Music Theatre. Since that time, he has become one of the country's most well-travelled performing artists. Trent Arterberry has taught mime at Boston University, The Boston Conservatory, the Walnut Hill School, and his own studio in Belmont, Massachusetts.

Melodie Hicks Arterberry founded the Belmont Children's Theatre where she staged over 20 productions with children. She has done numerous in-school theater residencies across Massachusetts and has directed "The Christmas Revels" in Philadelphia.

Project (M2-308A)

Physical Prestidigitations: Student Multimedia Simulations

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Key words: physics, hypermedia, multimedia, computer integration, simulation, peer collaboration

Abstract

The Physical Prestidigitations Project is an expression of the continuing philosophy that guides the teaching of middle school students at the Baker Demonstration School (BDS) of National-Louis University. Content and process skills are integrated throughout the curriculum even though individual teachers and classes may be identified as science, technology, social studies, or other subject areas. Students construct their knowledge in a collaborative environment. The culture of this environment includes peer collaboration, cross-grade student interactions, and faculty-faculty and student-faculty collaboration.

This project involves the eighth grade students at BDS, the science teacher, the technology teacher, and selected students in fourth and fifth grades. As seventh graders, the students learned hypermedia authoring as part of a unit in science entitled The Hypermedia Zoo. These students also designed stacks using *HyperStudio* for a Latin project as part of the technology curriculum. As eighth graders, these students are exploring various multimedia packages and evaluating their effectiveness as vehicles for independent study on specified topics.

Body

As an essential element of their study of mechanics this year, the eighth grade students are designing a hypermedia simulation of a investigation studying the motion of a wind-up toy and another toy of their choice. The purpose of the simulation is two-fold. First, the simulation will be used to assess how effectively the student authors understand the relationships among distance, time, speed, acceleration, mass and force of moving bodies. Second, they will use their simulation to introduce a fourth or fifth grader to the study of physics. The simulation is a preview for an actual investigation the individual fourth or fifth grade student will perform under the guidance of the eighth grader. In their technology class, the eighth graders are learning more about scripting, stack design, and the use of QuickTime™ and colorizeHC™ to insert color video images within the hypermedia simulations. Visual information sources include: student drawn animation, scanned photographs, video clips, still video images, and sequences from *The Visual Almanac*. Text information is derived from class activities in science and individual investigations designed and implemented by each student as part of the science curriculum.

Students write several reflective summaries during the project describing what they are learning. Written at the end of the unit, a more structured summary includes: a summary of what the student has learned, an evaluation of what the lower grade student experienced, a self evaluation of the specific simulation, and an evaluation of the teaching methodology to provide feedback to the science and technology teachers to shape the implementation of this project with next year's eighth grade class. These two forms of discourse serve as a basis for examining themes that emerge as the students construct their knowledge.

The presentation of the Physical Prestidigitations Project will include an example of one of the simulations, video tape highlights of the interactions between the eighth grader and the lower grade student, and a discussion of the themes emerging from student reflective writings on this experience and observational and anecdotal data from the teachers.

Project (M2-308B)

An Interactive Multimedia Tour of the Indianapolis Zoo

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Key words: hypermedia, multimedia, interactive, zoo, middle-level education

Abstract

The reason for doing this project was three fold. First there was a need for some type of pre/post field trip tool for the Indianapolis Zoo. Second the authors want to see if a high quality multimedia project could be developed by middle level students, with adult supervision, using the resources they had on hand. Third the project would be developed on both the Macintosh (using *HyperCard*) and DOS (using LinkWay) platforms simultaneously. The intent here is that if two students are seated side by side but working on different platforms; they should be able to view the same screens. Since the authors are more proficient in scripting *HyperCard* the development of the *HyperCard* version is always somewhat ahead of the LinkWay version.

For the beginning it was decided that there should be as little difference as possible between the two versions. While this may not sound like a problem at the start of the project none of the authors knew LinkWay nor owned a DOS machine. Consequently all of the development on the project was done in *HyperCard* and then transferred or rewritten in LinkWay. The first problem encountered was how to make the graphics on booth versions identical. One solution might have been to scan the images on both a Mac and DOS machine but none of the authors had access to a DOS scanner. To solve this problem the images were scanned on the Mac, opened in PhotoShop, and saved as DOS TIFF images on a DOS formatted disk. The images were then opened in StoryBoard Live on a DOS machine and saved as .PCV files for use in LinkWay. While this may not have been the simplest way it did solve two problems. First the exact same images were being used in both versions, and second since all the software was already in place it was economical on the authors nonexistent budget.

The laser disc for this project was developed by a high school in Indiana on a grant from the State Department of Education. The disc was distributed free to all schools in the state that requested it. The authors want to make the use of the laser disc as transparent to the end user as possible. Therefore, it was important to find a driver that required little or no setup by the end user. For *HyperCard* the XCMD from VideoDiscovery's MediaMax was copied using ResEdit. This driver requires no setup by the end user. For LinkWay the standard drivers supplied with the program were used.

The Zoo had uploaded the fact sheets on its animals to IDEAnet (the I.D.O.E operated BBS). These fact sheets were downloaded as TEXT files and placed in both versions. To place color PICT files in the stacks/folders, the authors took 35mm pictures of the animals, had the pictures placed on a Kodak Photo-CD and copied the PICT files to the stacks. With LinkWay the PICT files will again be transformed using StoryBoard Live.

As one might think, it takes a tremendous amount of time to script such a project. To solve this problem, middle school students were enlisted as scriptors. Different groups of students scripted each biome within a structured frame work. The structure was open enough so that each group of students could express there own creativity. By having the students use some common elements, different biomes would have a similar look and feel.

Society Session (M2-310A)

"Mission Earth" Symposium: World Simulation for Education (SCS)

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Key words: simulation, modeling, subsystems

Abstract

It is educational for students to study an existing world simulation—or better yet—to develop their own world simulation by cooperative effort. For the past 20 years or so there has been relatively little progress made in world simulation in the area of modeling methodology. World simulation has continued to use only the methodology that was first applied by Jay Forrester of MIT in the early 1970's. This methodology consists of programming the solution of differential equations by means of the compiler Dynamo for early computers and its successor compiled for the Macintosh. It is important that world simulation evolve into the use of other methodologies. This goal could be a challenge for students and their professors.

"Mission Earth" guidelines and standards for world simulation

"Mission Earth" is an Activity of the Society for Computer Simulation which is addressed to investigating and reporting on the benefits to be achieved for world planning by means of its prime tool, namely, world simulation. "Mission Earth" strives to involve teams in world simulation, world modeling, development of standards and guidelines for world simulation, etc. The motivation of most of these teams is technical progress, but "Mission Earth" would like also to attract teams from colleges and universities having a mainly educational motivation. After all, it is these students who must carry the field forward in later years. The old timers presently working in world simulation will soon shuffle off the scene.

Research Needed

Much research would be desirable in order to evaluate the relative value and roles of the various modeling methodologies, which include:

1. continuous time
2. discrete event
3. combined (1 and 2 coupled together)
4. stochastic (versions of 1 or 2, with statistical variation between and during runs)
5. one very large model, or iteration among a number ot submodels
6. Automated optimization or selection of a "best" plan by human judgment

Research is needed also into questions of accuracies required in different types of input data, run durations to be usp and relative importances of variables. There is also a task in applying industrial engineering the organization of the efforts for most effective performance.

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Society Session (M2-311A)

Quality Learning Through Technology (ISTE SIGTC)

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Key words: TQM, quality, restructuring, technology, public education, assessment

Abstract

Educators can use Total Quality Management (TQM) principles and tools to plan for, implement, and assess students' learning through technology. The TQM principles of consistency of purpose and continuous improvement give teachers and students frameworks for improving learning. TQM tools such as quality matrix, force field analysis, and benchmarking provide the teachers and students feedback and assessment on the quality of learning. Educators can use TQM to help students 21st century skills, to work on higher levels, and to self-assess and improve as they do subject area technology projects. Classroom examples of TQM relating to outcomes, projects, and assessments will be supplied.

Special Session (M2-312A)

Using Multimedia to Create Adaptive Learning Environments

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Key words: multimedia, art, computer graphics, Logo, elementary

Abstract

Our intention is to promote discussion amongst the attendees on developing multimedia environments for children. We want to address today's applications and tomorrow's possibilities for enriching students' lives through multimedia developments. Our discussion will draw on educational theories and practical experiences. We will move from Lorelei Jones' work in teaching art and computer graphics to her high school students to Michele Evard's work with children at the Computer Museum's Computer Clubhouse to Allison Druin's work in creating physically immersive environments where, for example, all the objects in a room including its walls, floor and ceiling are objects for learning and construction. As panel chair and moderator, Solomon will relate these activities to their historical antecedents from her previous work in developing Logo environments for children.

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Project (M2-313A)

A Three Year Plan to Infuse Technology Throughout a Teacher Education Program: Year 3 Update

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Key words: undergraduate, technology program, teacher education

Abstract

If new teachers are to use technology effectively with their students, they must have appropriate experiences and instruction throughout their pre-service program. Creating models for educating faculty and successfully infusing technology throughout the curriculum has been problematic, however, for teacher educators. In this paper, a model program integrating technology into teacher education will be described., with special emphasis on activities in the third year of the program, 1993-94.

Over the past ten years, the College of Education at Iowa State University has developed a technology program for undergraduate teacher education students that is designed to make technology an integral part of the teaching and learning environment. The first two components of the program are part of the curriculum for all teacher education students; the third component is designed for students who wish to specialize in the area of technology. The program, designed to model the uses of technology teachers will be using with their own students, includes the following three components:

1. a course in computer-related technology
2. computer-related technology experiences in foundations, methods and field experience classes
3. an optional minor in educational computing that includes eighteen credits of coursework in computer-related technology topics.

Project (M2-313B)

The Great Bulb Race and Beyond: Two Elementary Telecommunications Curricula

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Key words: telecommunications, elementary, horticulturist, science, multidisciplinary

Abstract

"The Great Bulb Race and Beyond" and "Primary Students Research in Tandem with Horticulturists" are two on-going telecommunications projects at C.P. Smith in Burlington, Vermont. The elementary school is working closely with Saint Michaelfs College for technical assistance and National Gardening Association for on-line horticultural assistance.

"The Great Bulb Race and Beyond" will allow fourth and fifth grade students to watch the development of spring from south to north through tracking the blossoming of bulbs. In the fall, all 13 participating schools across the states and the United Arab Emirates will plant their donated Brecks bulbs. They will keep track of average weekly temperatures for each of the 13 schools and predict which bulbs will blossom first. All schools will upload descriptions of their planting areas and

height and weight of bulbs in grams. During the winter they will have a similar project with indoor amaryllis bulbs. All communications is made possible through donated CompuServe accounts.

First and second graders will be researching the reliability of new Burpee vegetable seed packages. The children will test new Burpee seeds and compare their results with the master gardeners across the country. If the children and the master gardenerfs tests are positive, they will recommend that Burpee put the seeds on the shelves for sale next spring. The communications will occur via CompuServe. The technical support is provided by Saint Michaelfs College and the on-line horticulturist at the National Gardening Association.

Presentation

Anne Judson, the author of the projects, and Leslie Ward, a participating fifth grade teacher from Alburg Elementary School, Alburg, Vermont, will discuss childrenfs learning, pros and cons of telecommunications, and will demonstrate CompuServe's important role in these projects.

Special Session (M3-BRAA)

Learning Where the Truth Lies: Use and Abuse of Multimedia

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Key words: multimedia, learning, presentation, misrepresentation, manipulation

Abstract

This paper raises the issue of intellectual responsibility on the part of designers of multimedia products as well as student generated multimedia projects in the classroom. The ease and glamour of multimedia has shifted the emphasis somewhat from content to style. A number of problems and solutions are presented. Relevant issues in related media are discussed.

> How many lies did it require to make
> The portly truth you here present us with?
>
> — Robert Browning From "Mr. Sludge, 'The Medium'"

It depends on your point of view

One of the favorite pictures which I shot in Nepal shows a boy on a wall silhouetted against the twilight sky next to the sloping roof of a Buddhist temple. The boy has his arms raised up, hands clasped together in a prayerful gesture. It is a beautiful composition and inspiring notion. However, a second shot taken with a telephoto lens reveals another story. In it you can see the string trailing from his hands and a tiny kite floating above. How important is that kite? It's hardly even visible in the wide shot. Is there anything wrong with using this image in a multimedia montage on religion and culture? For many in a hurry to communicate their message, nothing would be wrong with that. The image does the job, the point is made. Accuracy has become expendable. I think such thoughts, or rather, such lack of thought, is pushing multimedia in a dangerous direction. Designers and producers risk undermining their own credibility and the future of the field in general.

The issue is not unique to multimedia. Howard Becker asks, "Do photographs tell the truth?...If we are going to use photographs as evidence for social science assertions, we need to know whether they can be trusted as evidence, whether and how they 'tell the truth.' "* The truth has been abused in all media from photography to cinema to television. Ten years ago,

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*Howard Becker; "Do Photographs Tell the Truth", *Afterimage*

National Geographic digitally moved the Giza pyramid sideways in one of it's photos so that it would fit their cover format.[**] Re-enactments of stories on CBS news were passed off as the real thing. Recent "documentary" films like "JFK" and "Roger and Me" have played fast and loose with any attempt at objectivity. A colleague of mine won't go to see "JFK" because he is sure his visual memory will be infiltrated with untrue images which he will be unable to censor from this thinking.

In stumbling across a few examples of this sort and discussing the problems with others, I have discovered there is a large arena of issues—which many others have been wrestling with much longer than I. The issues arise not just in the media, but in fields as diverse as psychology and anthropology. I am not claiming any particular insight or expertise. Many of you may have thought more about this topic than I (in which case I will be most interested to hear your comments). For me, these notes are a work in progress, to get some ideas down on paper and start a dialog.

The medium is the message

One of the first warning signs for me came shortly after the Apple's laser writer launched desk top publishing. Those lucky kids (early adopters we call them) who had access to the Macintosh on their Dad's desk discovered that they could produce a terrific looking school report. More importantly, they discovered that they could get an "A"—as long as it **looked** good. In fact, if it looked good, the ideas hardly mattered at all. They had learned a most important lesson—"The medium is the message." Judah Schwartz calls it the "celebration of impresario rather than the creator." When teachers finally caught on and started actually reading these reports, the kids ran spelling checkers and bought themselves a little more time. Next some discovered the power of an on-line thesaurus which can substitute wonderfully erudite variations at the click of a mouse, never mind that the kids may not have the slightest idea of the meaning.

Nowadays many teachers and some students acknowledge the fact that fancy format shouldn't make up for weak content. But the amazing thing is that nothing has changed that much. Everyone is still seduced by slick reports. Even when I see my rough my rough drafts coming out of the laser writer I can't help thinking how much better my writing is. By no means is this is to say that desk top publishing provides ad art tools simply to impress the reader. Page layout, graphics, fonts, etc. create a significantly more powerful medium for communication than plain text.[*] The right graphic composition can be just as important as a well turned phrase. Why aren't these skills being taught in school along with (or even in place of) cursive handwriting and spelling?

In any case, kids and the technology will always be one step ahead (of the teachers). Now kid's are having fun and getting A's with multimedia reports. Students are learning a lot about media and creative expression—which is fine except teachers often think they are still teaching history or geography.

Multimediocrity [**]

Plagiarism is considered to be one of the worst sins in academics. Even with the ease of word processing, it is still unethical to copy another writer's words without acknowledging the source. But for some reason, cutting and pasting video clips and sound bites is the norm in multimedia reports. Why are students are expected to create their own original text, but when it comes to images they can only re-purpose or edit someone else's footage? Certainly there are differences in the media and in the technology, but careful thought should be given before we lower our standards or redefine the ethics of what constitutes creative composition and original thought.

The ease of casual cutting and pasting images gives rise to enormous temptation. If you can't find the right image (or if the right image is the wrong format or contrast) why not use another one to make the point (even more effectively). When students couldn't find a picture on the GTV videodisc to illustrate a battle in the War of 1812 they conveniently used one of a carriage crash in New York instead! Somehow it illustrated the feeling of destruction which the students wanted to convey. Nobody seemed to mind very much. Another group of students trying to illustrate a scene from the Greek myth of Cupid and Psyche used footage from the Visual Almanac to convey the emotion of anger. The clip was high speed photography of a Coke bottle being smashed with a hammer. To their credit they discussed whether their choice of visuals was legitimate and decided they were operating in the realm of creative expression. Unfortunately the emotion they elicited with such an anachronistic juxtaposition had more to do with laughter than anger. There are surely hundreds of better anecdotes about this academic variation of artistic license.

The issue is not new or unique to multimedia. We can, and should, learn where the limits of academic accuracy lie by examining related media. It is a problem that many filmmakers have wrestled with. Compare the examples just cited with the standards of accuracy of Ken Burns. The Civil War documentary filmmaker, is always concerned with how far the filmmaker can go. Putting the voice of one soldier complaining about his morning coffee while showing the picture of another soldier holding a tin cup is the kind of equivalence that is legitimate. On the other hand, using the photo of a corpse at Antietam to illustrate the quotation from a soldier at Gettysburg is not, in Burn's view.[***] We may expect professionals to be more conscientious about academic standards than students, but notice our double standard with which we make a distinction between a student's written text and a student's multimedia images.

[**] *National Geographic*, cover, Feb. 1982

[*] If the cobbler's son had shoes I might have found time to include illustrations in this paper

[**] term coined by Ted Nelson

Manipulating Information

One of the great benefits of multimedia is the interactivity which allows the user to dive into data and "manipulate information." With semantic irony, that double-barreled phrase takes on a negative connotation in another context not so far removed.

> "There's such a dangerous power to manipulate in film. Jean-Luc Godard, one of the fathers of new-wave films, was famous years ago for saying that film was the truth twenty-four times a second. But I think it can also lie twenty-four times a second." [*] (Of course Macintosh QuickTime movies can only lie ten to fifteen times a second.)

More ominous than transparent amateur efforts are the programs created with professional Hollywood high production values which disguise the extent to which the producer has manipulated the interpretation of the information. Two of the most effective techniques of the designer/producer are:

- the soundtrack. Voice, background music, 24-track mixers, etc. can elicit powerful emotional responses. Producers of TV commercials know how to bring the viewer to the edge of tears within a 30-second spot in the middle of a basketball game.
- fast cutting montages. The rapid juxtaposition of images in the best MTV tradition (almost subliminal) can become propaganda more than exposition.

Some multimedia producers have perfected both of these techniques in so-called "synapse sequences" which leave the viewer's mind gasping for breath as it races in vain to keep up with the viewer's emotional response.

The issue is not simple. It has as much to do with the difference in medium as with any moral position. "Film is not equipped to do what a book does, which is to attain profound levels of meaning and texture. But film has the power to reach profound levels of emotion.... I think that in allowing history to be defined and presented exclusively by the academy, we've bled it of its powerful emotional aspect....I believe film is uniquely equipped to transmit that kind of power. It can be our Homeric form...I don't want to oversell my medium, because it is so easy for it to fall into irresponsible hands that would promote our dangerous national addiction to images designed to manipulate us."[**] For Burns the dilemma is to find the middle ground between being too academic and abstract on the one hand and succumbing to the formulas of Madison Avenue.

From the particular to the general

The problem cited above of using images to support writing is not easily overcome. Even if the multimedia author is conscientious about researching "accurate" pictures, another problem remains when the particular case is meant to represent a general trend. When unemployment rises one tenth of a percent, TV news shows a graph and then brings its cameras into the living room of Joe Smith to more effectively convey to the viewer what it can mean to lose your job. The use of such case studies is a responsible and important part of media. Generalities can leave the viewer detached with only a superficial understanding. Images capture the viewer's imagination and provide a richer setting in which ideas can be visualized. While sentences or statistics can be abstract and general; pictures are always particular. The average family has 2.1 children, yet no home has such a portrait sitting on the mantle. Joe Smith may share many of the experiences of the newly unemployed, but they are not trying to support Mildred, his live-in mother-in-law.

Howard Becker points out that all photographs are about particular situations, but that they are inevitably interpreted as representing general context. If generalizations were not implied, viewers would be much less interested in the pictures. For

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[***] Ken Burns; "The Arrogance of the Present is to Forget the Intelligence of the Past, *American Heritage*

[*] ibid.

[**] ibid.

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example, Owen's photography book is called Suburbia, not "Livermore" because if it needs to make a statement about American life in general, not about a particular town in California.*

What are the criteria for choosing representative images? How does the viewer extract those aspects which have general relevance and dismiss those which are unique? Anthropologists and some psychologists whose main research methodology is the case study may have some answers. Multimedia may also provide its own new solutions as we shall see later.

Seeing is Believing—and vice versa

We take it for granted that seeing is believing. It is both the power and the danger of visual learning. We have all learned to believe that the earth rotates on its axis, but everyone of us, including astronomers, still sees the sun sinking into the ocean at sunset. We should be saying "earth rise."

Here's a little verse which sums it all up—with thanks to Kathy Wilson and apologies to Michael Jackson:

- Who Knows Where the Truth Lies?
- The day is 24 hours long,
- The teacher is never wrong.
- When we see the sun rise,
- We forget the truth lies.
- It's day, it's night.
- It's black, it's white.

Learning how different frames of reference affect what you see is one of the objectives of "Playground Physics" the Visual Almanac. When viewers watch the visual illusion of a ball rolling across a spinning merry-go-round they "see" the path of the ball as a pronounced curve outward. Some with enough background in physics know better—"It's actually traveling in a straight line." On-line measurement shows that neither is exactly right. The path curves slightly inward (because of friction).

One of the compelling advantages of the Visual Almanac videodisc is that it presents a real-world view which can draw students in, motivate their learning and provide a rich visual scene upon which they can build and apply conceptual frameworks. One of the disadvantages of videodiscs is that the content cannot be readily manipulated. You cannot speed up the rotation of the merry-go-round or experiment with changing the weight of the ball, etc.

However, as TV goes digital and computers "go video" it will be easier to simulate these variations by compositing the elements together on the fly. One of the prices we will pay for this progress is the credibility of the image. It will become harder and harder to distinguish between footage which has been recorded and that which has been synthesized. It will all seem equally real. Voyager mission fly-bys of the planets have yielded spectacular footage which JPL has used to create low level fly-overs of 3-D terrain maps. The computer will increasingly follow in the footsteps of the world of cinematic special effects. It remains to be seen whether synthesized computer simulations will be enhanced by real-world look and feel or whether they will further undermine our faith in believing what we see.

In any case there is a new phrase afoot. "I'll see it when I believe it."* That's one possible explanation for the verdict in the Rodney King videotaped beating trial. It also may explain public reaction to the Clarence Thomas confirmation hearings. The public was profoundly divided between those who thought Thomas was lying and those who thought Anita Hill was lying. One might expect to find some correlation by gender, race or age. There was an overwhelming correlation, but it was not by any of these categories; it was by political affiliation. Among the public at large, registered Republicans believed Thomas, Democrats believed Hill. As every magician and 3-card monte con artist knows people will see what they believe (or what you can trick them into believing.)

Some interesting discoveries about what people see vs. what they think they see were made as long ago as 1920 when Lev Kuleshov conducted an experiment in the cut-away. His group "took three identical shots of the well-known ... actor Moszhukin and inter-cut them with shots of a plate of soup, a woman in a coffin and a little girl.... Audiences exclaimed at

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*Howard Becker, "Do Photographs Tell the Truth", *Aferimage*

*Robert Ornstein; *Pyschology of Consciousness*

Moszhukin's subtle and affective ability to convey such varied emotions: hunger, sadness, affection."[**] The actor's "enormous talent" in using the subtlest facial expressions to reveal such different reactions was completely invented by the audience who projected their own feelings. The juxtaposition of sound can be similarly effective. Simply changing the sound can redirect the viewer's focus and interpretation of a picture.

Realer than real

In the early days before we called it multimedia, I was testing users with the Aspen Movie Map (the surrogate travel videodisc system we developed at MIT). The subjects were people who would soon be visiting Aspen for the first time. In her explorations of the town one woman headed north on Mill Street. The footage ended after a few hundred yards as the road headed out of town. Due to a bug in this alpha version of the system, she couldn't even turn around. The program had to be restarted. She ended up spending about an hour exploring the virtual environment of Aspen and had learned to avoid heading out of town on Mill. When she visited a week later, she was instantly familiar with the town and very confident finding her way around. At one point she was invited to visit a friend's home on Red Mountain. The friend gave her instructions over the phone. "Turn left on Mill Street and drive north for 5 miles..."

"Well, ok.... But I don't think you can do that!" she responded dubiously.

There are hundreds of examples of the power of multimedia. Media can be more powerful and memorable than reality. A number of reasons come to mind:

- Multimedia is interactive. So is reality. But in many cases the computer version has been customized to encourage fast, easy iterations and variations which are often cumbersome to test in reality. The user often can form and test hypotheses within much shorter time frames (or attention spans).
- It's repeatable. Digital media is infinitely repeatable. Reality never repeats exactly. In a crucial close call or spectacular play in a football game, I remember the slow-motion replay from multiple angles much better than what I saw with my own eyes in the stadium.
- It can be authored, filtered, choreographed and edited for specific purposes in a way that reality can't. There is no background music in real life, no scriptwriter or director assembling the plot in advance. We only do it retroactively (unless we spell Director with a capital D.)

White Lies

The weatherman stands in front of a blue background gesturing at empty space; the viewing audience sees clouds racing across the Europe and high temperature marks superimposed upon a map of England. The weatherman views and adjusts his positioning with the aid of an off screen monitor carefully placed so he can pretend to be looking at something else. In the beginning monitors were off to each side to foster the pretense that he was looking across the map, but few were fooled. Many stations also used to wipe from one meteorological map to another while the weatherman pretended to slide a vertical mullion across his virtual stage. That definitely fooled nobody. Today the pretense has vanished. The monitor is placed next to the studio camera, so the weatherman can look directly at the audience while he gestures as if he had eyes in the back of his head. The maps switch without fanfare and the commentary makes the transition in mid-sentence.

The format has become the standard way conveying information in the most understandable way. The "tricks" are so widely known that you use the example of the weatherman to explain the technique of chroma key to someone rather than vice versa.

In this case the truth lies, but it is a little white lie which everyone accepts. It does no harm precisely because it has become a convention and because the illusion is in form, not content. For contrast consider infra-red satellite photos of temperature gradients. These look for all intent and purpose like radar views of cloud patterns. While there is a high correlation between the two, they really represent different data. When one is misrepresented as the other, the misinformation is less benign.

Learning because the truth lies

It may be tempting to assume learning is best served by access to the whole truth. Paradoxically teachers often find themselves leaving out parts of the picture so not to overwhelm beginning students with unimportant complexity. Imagine if you couldn't teach basic Newtonian physics without resorting to relativity. Many lies are told in the name of simplification.

[**] James Monaco; *How to Read a Film*

"Don't worry about that now, you'll get the full story next year." "This is the totally elastic collision between two bodies on a frictionless table."

Designers often simplify the underlying model not just because it is too complicated to teach to the student, but because it is too hard for them to figure out how to teach it to the computer.

Multimedia educators like Sam Gibbon set incredibly high standards for being honest with their student audience. They are as accurate and complete as they can be and add disclaimers whenever they have had to leave out or fudge any aspect. Yet, after being so conscientious and responsible they are discouraged to find that students don't want disclaimers. It lessens their motivation. Just as in politics and love, a simplistic lie is sometimes more desirable to hear than the messy truth.

One problem of course is who decides what to leave out; who decides which model is right for the user?

The Problem is the Solution

It would be easy to go on and on about the dilemmas faced by designers and users of multimedia products. However, if I ever want to wrap up these notes it's time to think about how some of these problems can be resolved. As with many technologies parts of the problem can be reformulated to become part of the solution. Here are a few of cases in point:

Transparency

One of the goals which multimedia designers take the greatest pride in is the transparent interface. Everything should be so clear, intuitive and obvious, the user doesn't even notice the hand of the designer; he or she is directly engaged with the content. While this is admirable (not to mention greatly challenging), from a certain point of view it can lead in a unwise direction. Most multimedia applications (especially simulations) are based upon some underlying model derived from the real world. That model should be visible to the user; it should not be the part of the interface which is so well-designed that the user never sees it. If I am looking through a single lens reflex camera, the technology is transparent—I am directly engaged with the subject. However, if the lens has a polarizing filter on, I need to know that it is there and how using it manipulates the image in front of me.

When the designer makes the underlying model explicit to the user two important things happen. First, the designer is off the hook. He or she has taken the responsibility for being honest with the users. Limitations, constraints, simplifications are acknowledged. Hopefully the result will be less misinterpretation and misuse. Second, users are learning not just about the subject matter but also about modeling and representing the content. This puts a powerful tool in their hands for constructing their own models both internally and on the computer.

Multiplicity

As noted earlier case studies pose a problem for linear visual media. They are extremely helpful because they are so literal, but that very specificity makes generalization risky. Since multimedia is interactive and non-linear it provides a refreshing alternative. Tens (or hundreds) of cases may be made available those users seeking the fuller story. They are not just stuck with Joe Smith and his family; they can, if they want, draw more complex conclusions from investigating a wider sample (of an unemployed single mother, an auto plant closing in Michigan, etc., etc.) To be sure, this doesn't completely solve the problem, because each of those other cases is specific as well. Who chose them? Is each of them representative of a general situation? Nevertheless, it allows users who want more to get a **better** handle on the content—and to conduct their own investigation.

Multimedia is full of multiplicity—multiple representations, multiple points of view, multiple levels, multiple purposes, etc. As a designer it is probably not a good idea to take the notion that you can include **everything** for the user. There will generally have to be editorial filtering. In fact, some of the most successful multimedia products are those in which the author's views drive the design. In some cases, the key to good design will depend on providing the balance between authorship (on the part of content expert) and research (on the part of the user).

Sound bite learning

Another "solution" that multimedia may provide is somewhat discouraging. In this fast-paced age of the sound bite, the ten second TV ad and the USA TODAY picto-graph, messages are becoming incredibly compressed. It is not because we have a short attention span, but because our attention is being fractured by a multitude of signals competing for mind share. We simply don't have time to dwell on any issue for very long.

Believing that the multimedia author/producer has a responsibility to be honest, accurate and open might make me old-fashioned. The younger generation may be consuming media at a rate that doesn't allow time for nuance, depth or reflection. While we may bemoan this development, it may becoming a fact of life for those who need to stay abreast of an increasing flow of information. If so, then some of those very examples which sacrifice truth for the sake of a more powerful message may be positioning multimedia for the future which our society is building for itself—whether we like it or not. It is possible that those who subscribe to this expediency will learn more about a greater range things that they need to know than those who explore a narrower domain more deeply.

Critical Review

As noted earlier, most of the issues are not new or unique to multimedia. Print, TV, cinema, etc. all have established traditions about what is kosher and what isn't. Literary criticism, film criticism, etc. are useful and necessary in the development of their respective media. It is time for multimedia to establish its own conventions, its own rules. It is time for critical thinking and critical review. We need multimedia critics. They should not just to look at interface, interaction and production values but also at the representation of the content and the underlying models upon which products are built.

I am interested in hearing from others about the issues presented in this paper, especially with regard to examples encountered by students and teachers in classrooms. Please send any comments or examples which you think may be of interest in furthering this discussion to me at the above listed address, fax, or E-mail.

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Society Session (M3-201A)

Towards A Research Agenda In Educational Technology: What We Know About Educational Technology That Can Help Schools (ISTE)

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During the NECC 94 research session, the status of educational computing both in the United States and internationally will be reviewed by researchers doing significant work in each of four basic areas: utilization, international comparisons, teacher education, and effectiveness. The information provided by this panel will explain what we know about educational technology that can help schools. The panel will be chaired by Kathleen Fulton of the United States Office of Technology. She will bring her insight and perspective to the panel gained from coordinating a nationwide survey of the status of educational technology.

Panel Topics

What Is the Barrier—Not Enough Computers or Not Enough Computer-Knowledgeable Teachers?

Henry J. Becker, University of California—Irvine

What Can Be Learned from International Comparisons

Ron Anderson, University of Minnesota

Information Technology and Teacher Education: What We Know and What We Need

Jerry Willis, University of Houston

Reviewing Recent Reviews of Technology's Impact on Learning

Peggy Roblyer, Florida A&M University

Special Session (M3-202A)

The New Vision of Assessment

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Key words: assessment, technology, portfolio, observation, progress

Abstract

Assessment should support the continued learning of each student. Because this vision implies a dynamic process that continuously yields information about students' progress, there is a critical need in education. It is the development of innovative assessment techniques that support the emergence of new teaching strategies, reflect what we know about the process of learning, and measure higher levels of reasoning.

Studies by the Office of Technology Assessment (OTA) and the Association for Supervision and Curriculum Development (ASCD), as well as state reform movements, identify the importance of a variety of assessments. In addition to standard written and multiple choice tests, these include oral discussion, group work, portfolios, peer grading, and observation, as well as self-assessment and performance-based assessment. To implement these new ideas, teachers will require methods of tracking and recording that are unobtrusive and adaptable. Also needed are assessment tasks and scoring techniques which focus on higher levels of thinking.

This special session will address these changes in thinking about assessment and examine new technology solutions that make the difficult task of assessing students' learning a manageable and natural part of the teaching/learning process.

Special Session (M3-203A)

Integrating Technology into Teacher Education: Redefining Literacy

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Abstract

The evolution of telecommunications technology as a significant force in curricular use of microcomputers has changed the functional definition of "computer literacy". This panel discussion brings together persons illustrating the full range of administrators and teachers in Indiana who are regional co-participants in the redefinition of computer literacy as broader "technological literacy".

Within the last decade computer ue in the K-12 Schools has grown. There appears to be movement from learning ABOUT technology to using technology as a medium through which learning is enhanced. Not surprisingly, these trends are causing some in Teacher Education to a questions concerning teacher preperation. For example: How has the the definition of computer literacy changed (U.S. OTA Assessemnt 1981988)? What is actually happening with technology integration in the U.S. K-12 schools? How does this information impact on decisions regarding the integration of technology in teacher education?

Ball State University in Muncie, Indiana has tritionally been considered a strong mid-western teacher education program. The emphasis in the teacher education program at BSU has been on clinically-based learning with an undergraduate pre-service teacher preperation program. Field experience is integrated as a component of most pre-service teacher education classes at Ball State University.

In the last ten years Teachers College at Ball State University has begun to integrate technologyin teacher education. At present, all faculty members have either a DOS or a Mac microcomputer in their offices, most faculty have connectivity tothe BSU mainframes, a well equipped Macintosh laboratory is available for exclusive use by the TC faculty and another University supported microcomputer lab is also available in Teachers College. Recently, the Burris lab school (K-12 laboratory school at BSU) was remodeled and outfited with several microcomputer labs, microcomputers in every classroom and ethernet connectivity for all the Burris Teachers.

In the last few years developments in telecommunications at the national and state level have created enormous pressure to make computer telecommunications (E-mail, Gopher, FTP, WAIS, etc.) a significant part of technological literacy. In Indiana, the IDEAnet statewide educational bulletin board system is available to all K-12 students and teachers and to students and faculty in higher education. Students learning about classroom technology integration at Ball State University routinely communicate with teachers and students throughout the state of Indiana through IDEAnet.

The purpose of this panel discussion is to bring together persons illustrating the full range of administrators and teachers in Indiana that are co-participants in the redefinition of computer literacy as a broader "technological literacy". Participantsill include teachers, administrators, state program coordinator, university faculty and the Dean of Teachers College at Ball State university. Each participant will persent a brief statement of their viewpoint on the meaning of technological literacy and provide illustrations of is defination may mean in human terms; that is what the definition means for the everyday activity of teachers and students in Indiana's K-12 schools and higher education institutions. Audience participation in a question and answer session will be encouraged.

Special Session (M3-204A)

Teaching Ethics in Computer Courses

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Key words: computer ethics, ethical decision making, teaching ethics, ethics cases

Abstract

We, the presenters of this workshop, would like to start with an admission, which we will assume is also true of the majority of the audience, as teachers in a computing discipline: **We're a lot of things...but we're not trained ethics teachers.**

Instructors in IS and CS programs come from varied backgrounds including math, engineering, business and the liberal arts. This is still true even with the number of CS and MIS degrees now being granted. But few teachers in these technical disciplines, if any, have backgrounds in philosophy or ethics. We naturally feel uncomfortable tackling computer ethics in the classroom.

Purpose

This session is for teachers, computer scientists, information systems professionals, and computer users. It is meant for those who (1) want to know more about ethics, (2) want to gain some experience dealing with ethical dilemmas, and most of all, (3) may be called upon to teach computer ethics.

Furthermore, the session is constructed with the inexperienced computer ethics teacher in mind. A computer ethics teacher does not need to become a philosopher in order to deal effectively with the subject matter. Sufficient background will be provided in ethical decision making and its underlying principles. The connection between information technology and ethics is also explained. Real world cases are used to illustrate the steps for analyzing a specific situation and making defensible ethical decisions.

Overview

Among the topics to be covered are:

- Ethical decision making
- What makes computer ethics different
- Making ethics happen in the classroom
- Case analysis techniques
- Choosing cases
- Using cases: requirements for teacher and students
- Managing the discussion
- Managing the classroom
- Where to find the time
- How to evaluate student learning
- Suggested readings and references

Project (M3-206A)

Interactive Multimedia Applications in Education

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Key words:

Abstract

The presentation highlights three multimedia projects developed by Technology Based Learning and Research at Arizona State University. The projects descriptions are as follows:

Teaching Mathematics Methods Using Interactive Multimedia*

The Teaching Mathematics Methods Using Interactive Multimedia project is a model digital video multimedia instructional program to prepare pre-service and in-service elementary teachers to integrate content, manipulatives, and methods, into their mathematics learning. The instructional system combines digital video, audio, text and graphics to give pre-service and in-service teachers a large variety of authentic views of expert classroom instruction using NCTM Teaching Standards suggesting teacher methods and mathematical manipulatives.

Arizona State University Hispanic Math Project*

The project is an interactive video program (consisting of six compact discs) that combines digital video and animation to deliver instruction that is developmentally appropriate and user-friendly. To complete each lesson, students must help cartoon characters through a variety of mathematical adventures which require the use of measurement devices. Each bilingual lesson features testing, multiple learning paths, and an abundance of video vignettes in which working adults model occupations and skills such as cartography, cattle ranching and banking.

Arizona State University Interactive Multimedia Instructional Media Design Course**

The Interactive Multimedia Instructional Media Design Course consists of a compact disc and includes the following instructional units: Media Selection, Instructional Objectives for Multimedia Applications, Performance Assessment for Multimedia Applications, Screen Design for Multimedia Applications, and Formative Evaluation of Multimedia Applications. Credit is available via Internet.

* Funded by The National Science Foundation and IBM

** Funded by Intel

Revolutionary Classroom (M3-207A)

Teacher and Students as Co-conspirators in Learning

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Key words: multimedia, collaboration, constructivism

Abstract

What can transform a traditional middle school science classroom into one where the teacher and students become co-conspirators in learning? The teacher needs to de-emphasize his or her role to the point where students become empowered to take charge of their individual learning. Although this is a laudable goal, can it be achieved? The purpose of this

presentation is to describe a classroom in which the teacher consciously encouraged a collaborative and exploratory environment grounded in constructivism, and thus became a co-learner—or co-conspirator—within the classroom culture. The classroom we will describe was part of the Hypermedia Zoo project, in which seventh-graders learned to use *HyperCard* to create multimedia research reports about mammals as part of their science curriculum. Based on our experience over three years of the Hypermedia Zoo project, these elements of the classroom environment are critical in establishing the co-conspirator nature of the student-teacher relationship: exploration, collaborative help-seeking and help-giving, student experts, self-reflection, and teacher as model.

What can transform a traditional middle school science classroom into one where the teacher and students become co-conspirators in learning? The teacher needs to de-emphasize his or her role to the point where students become empowered to take charge of their individual learning. Although this is a laudable goal, can it be achieved?

Purpose

The purpose of this presentation is to describe a classroom in which the teacher consciously encouraged a collaborative and exploratory environment grounded in constructivism, and thus became a co-learner—or co-conspirator—within the classroom culture. In a traditional classroom, the students view the teacher as an outsider to their learning and social culture. In this student-centered classroom, co-conspiracy developed when the students invited the teacher to be part of their culture.

The Curriculum

The classroom we will describe was part of the Hypermedia Zoo project, in which seventh-graders learned to use *HyperCard* to create multimedia research reports about mammals as part of their science curriculum. Each student observed, recorded and illustrated the physical characteristics, locomotion, and behavior of a specific mammal during four field trips to a zoo. Then they determined what information would be included in their report, organized it into screen-size cards, linked the cards of information together in a meaningful way, and presented their report as a multimedia document incorporating text, scanned graphics, videodisc images, recorded sound, and QuickTime movies.

The Learning Environment

Based on out experience over three years of the Hypermedia Zoo project, these elements of the classroom environment are critical in establishing the co-conspirator nature of the student-teacher relationship:

- *Exploration.* The teacher encouraged active, individual exploration in the hypermedia environment from the start. This exploration stage was critical in establishing multiple kinds of expertise among the members of the class.

- *Collaborative help-seeking and help-giving.* By modifying a choose-your-own-adventure stack, the students developed basic authoring skills for their *HyperCard* toolkit. In the process they learned to rely on one another to answer questions, solve problems, and acquire new information about *HyperCard.*

- *Student experts.* After the students started work on their mammal stacks, the teacher asked for volunteers to become experts on specific techniques: scanning, accessing the videodisc, recording audio, digitizing These students then became responsible for teaching their classmates how to do these things and for troubleshooting any problems.

- *Self-reflection.* Students journaling provided an opportunity for metacognition and also provided a self-assessment tool allowing students to set their own learning goals.

- *Teacher as model.* The teacher's role was two-fold: to model effective help-giving behaviors and to explicitly encourage students to share neat things they have discovered.

As students and teacher became co-conspirators in this classroom, they both learned, in the words of one student, " a lot of neat things."

Revolutionary Classrooms (M3-207B)

Analyses of Animals via Computer-Supported Intentional Learning Environment (SCILE)

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Key words: constructivist, internetworked, database, collaborative, knowledge, schema

Abstract

CSILE (Computer Supported Intentional Learning Environment) was conceived at the Center for Applied Cognitive Science at the Ontario Institute for Studies in Education. It has been the subject of a research study since1986 and in1992 it was sponsored by Apple ComputerUs External Research Group. Leonard School of Lawrence was chosen as one of six pilot sites throughout the United States. Leonard School is an inner-city public school that serves a multi- linguistic minority of low to lower middle class population. As a Revolutionary Classroom session, the students in Ms. Patty Knox's 7th grade class will present their Analyses of Animals Projects and demonstrate the CSILE software program.

Ms. Patty Knox, a seventh grade Leonard School Special Education teacher, in collaboration with Jeanne Fischer, a Doctoral student of The University of Massachusetts at Lowell developed a CSILE based collaborative knowledge-building teaching model. The teaching model is best characterized by the following quotation from Dewey (1963): The principle that development of experience comes about through interaction means that education is essentially a social process. This quality is realized in the degree in which individuals form a community group.

The presentation will emphasize the social constructivist approach in acknowledging CSILE software as a Rcognitive tool.S CSILE is a hypermedia system built around a student-generated database. It represents the future of collaborative software as a "knowledge habitat where cognition enhancers (or mind tools) leverage old skills and teach new ones; where mental abstractions are reified into concrete, manipulable objects; and where "intelligent others" mentor the user" (Carlson, 1992).

Design Principles

The design of the teaching model is guided by the goal of maximizing the value added to knowledge—either the public knowledge represented in the community database or the private knowledge and skill of the user. The overall principles for the teaching model are based on constructivist learning theories and characteristics of networked learning projects:

- Learners become more insightful and thoughtful knowledge workers.
- Learners use metacognitive strategies and skills.
- Learners promote comprehension by means of monitoring their understanding.
- Learners exploration is encouraged by support for sustained inquiry.
- Learners work as active agents in the construction of their own knowledge.
- Learners are contributors to the collaborative knowledge base of the learning community, in addition to being users of others' data and expertise.
- Learners focus on current, real, complex phenomena or events. This focus provides a motivating context for learning, inquiry, and collaboration.
- Learners attempt to create closer relationships among previously disparate communities

- Teacher and Researcher monitor the knowledge-construction activities via the CSILE software capability of making the learning process overt.

Software Components

CSILE is a multifaceted software system that is still evolving through ongoing research. In CSILE, the basic knowledge object is a note/idea. Notes are the object of inquiry and are compiled into note complexes within knowledge building environments. Students work cooper- atively to elaborate and upgrade information on-line with the sup- port systems within different knowledge building environments—including data explorations, explanatory skills, how-it-works analogy, and publication environments. The idea of a knowledge building environment is that knowledge is brought into the environment and something is done to it that enhances its value. Tools available in the environment are means which the value-adding work is done.

All of CSILE's component features are intended to enhance the potential of the communal database for collaborative knowledge building (Brett & Oliver, 1991).

- It is a multi-user database for systematic retrieval or organized information via access to internetworking.
- It is a text and graphic tool for students to use in producing their own project material.
- It can be a multi-user database of public notes with facilities for retrieval by Key words and other note attributes.
- It can be a communication medium through its commenting, importing, exporting and notification facilities.
- It can function as a medium for collaborative knowledge construction, through features such as note-linking and coauthoring capabilities.

Revolutionary Classroom (M3-207C)

Science for a Brave, New World

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Key words: science, middle school, curriculum, telecommunications, HyperCard

Abstract

Today's students need tomorrow's skills: today's teachers need tomorrow's tools. This paper describes strategies for utilizing the best of the currently-available electronic resources in a science curriculum which doesn't "Throw the baby out with the bath water," but preserves proven strategies from the past—field work, hands-on laboratory activities, and textbook studies.

Background

In 1993, Chico Jr. High School integrated its computer and science departments. Prior to 1993, the course offerings for 7th-grade students consisted of a menu of electives—students were allowed to choose one or two semesters of Life Science, Earth Science, Health, or Physical Science. In the new program "the sciences" are taught from a more integrated, thematic approach. All students are required to take a full year of science in the 7th grade and a combination of a semester of Health plus an elective semester of science in 8th grade. The science department teachers met during the 92-93 school year to plan a program that satisfied the curriculum objectives previously achieved through both science and computer departments. The following goals and objectives were identified:

Processes to experience—All students will be able to:

- write a plan to complete a project
- block out daily activities—establish a work agenda
- record progress in a journal
- create documents and supportive materials (e.g., videos, stacks, posters)
- synthesize information
- read, interpret, and create graphs, charts, and tables
- use the CD-ROM encyclopedia to access information
- collect data, analyze it and write summary statements
- design, conduct, and report lab procedures to test hypotheses

Computer Technology Skills students are to acquire include:

- word processing (spell checking and other editing; printing)
- *HyperCard* (chapter reports; flash cards; animations; controlling video disk player)
- use of paint and draw tools in MacPaint (and/or *HyperCard*)
- Spreadsheet/Database (entering data into; gathering data from; simple calculations)
- use of the scanner, CD-ROM, and Video disk resources

Scientific Content to cover in every 7th-grade course

- scientific method
- transfer of energy (biotic and abiotic cycles)
- using lab equipment safely
- conservation of mass and energy
- diversity, cycles, and change over time
- practical applications of scientific principles
- social responsibility

Practice

The author's 7th-grade class began with the first unit from Science 2000™, an investigation of the disease KURU as it was manifested in the Fore tribe of Papua, New Guinea. Topics covered included scientific inquiry, body systems, disease theory, the influences of society and environment, and the historic development of New Guinea. Students worked at the computer to analyze the spread of the disease, to view video clips of the tribe and their villages, to work through relevant simulations, and to gather information. We also had weekly use of a traditional science lab for studies of cells, tissues, and senses.

The next unit was devoted to an extensive study of a nearby National Wildlife Refuge. Students prepared for the field study by text study and by guest speaker presentations on species identification, energy cycles, refuge management, and avian morbidity and mortality. On the field trip students performed population counts, identified bird species, calculated the amount of food grasses in the refuge, observed gross dissections of birds felled by cholera and lead poisoning, studied macrobiotic and microbiotic water organisms, dissected owl pellets, and reported on signs of wildlife on a walking tour of the refuge. Technology was used in partial support of this unit: We hope that future refuge units will be supported by a telecommunication component: it would be wonderful to exchange information with distant students who have access to wetland studies in a different migratory flyway.

The study of ecology was continued with the next unit which also focused on teaching students to use *HyperCard*. Students were required to create sets of flash cards and to illustrate concepts like the water cycle and nitrogen cycle. The final project for the unit required them to focus on what *most* interested them. The stack created on this topic was to utilize scanned images, animation, and buttons that linked to video disk sequences.

The most compelling use of technology in the author's 8th-grade science class was participation in AT&T's Learning Network. Students used telecommunications to conduct a survey about the eating habits of their peers across the nation. This study generated a need to know how to use a database and spreadsheet and provided opportunities to apply learning personally. At the conclusion of the project, students shared their findings with the community at an open house. It was especially gratifying to see school district administrators and our state assemblyman in attendance! Students remarked: "I have taken a peek into the future..." "It's almost as though the walls in the classroom have been pushed out about ten feet and the door left open." "I'd say that this knowledge will benefit me for many years to come, and that the project will be one of the greatest educational experiences of my life."

Final Remarks

The Chico Jr. High School community believes that the restructured science program is truly revolutionary and will empower students to seek and manage information effectively. We will continue our efforts to strengthen and extend the infusion of technology, especially telecommunications, into the curriculum, and invite potential partners to contact us.

Special Session (M3-302A)

Cross-Classroom-Collaborative Learning: Circle Mentor Teachers Share Networking Expertise

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Key words: educational telecommunication, curriculum development, networking

Abstract

Currently many educators are working to support and design technology that will connect classrooms and make possible new learning communities of learners. Developing the technical structure is only the first step of the process of creating these communities. Learning how to integrate telecommunications with classroom instruction and to collaborate with distant peers is the new skill that teachers and students need to develop.

This panel is composed of Mentor Coordinators from the AT&T Learning Network, who are experts in cross-classroom-collaboration. They have been sharing their expertise year after year by helping new users learn how to work in collaborative groups to accomplish their educational goals. They will discuss classroom management and integration strategies that are effective for integrating telecommunications with classroom instruction.

Specifically they will:

1. Describe how they have used project on the Learning Circles to accomplish district technology plans and curriculum frameworks.
2. Discuss critical factors in the planning of Learning Circle projects and advice that they give to other teachers as teachers for successful student learning through team work with others.
3. Address issues concerning the technical design of communication software and technical support for cross-classroom teamwork.
4. Detail how the effect of telecommunications on students in terms of learner outcomes such as student involvement, creativity, global awareness, problem solving, and research skills.
5. Describe personal and school level changes that result from cross-classroom collaboration among teachers.

Project (M3-308A)

Hot Tips for Inclusion with Technology

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Key words: inclusion, disabilities, assistive technology, mini-authoring, multiple intelligences

Abstract

Restructuring and the inclusion of students with special needs are presenting new challenges to educators. The Boston Public Schools Special Education Technology Resource Center at Emmanuel College is trying to address these challenges. A variety of information has been compiled and/or developed by Center staff to facilitate the process of including students with disabilities in general classrooms with the assistance of technology. This information is summarized in an article entitled "Hot Tips for Inclusion with Technology" in the December/January 1993/94 issue of ISTE's *The Computing Teacher* journal.

Suggestions presented to assist teachers in creating the optimal environment for a heterogeneous group of students involve awareness/use of the following approaches/strategies:

- An initial technology-based evaluation by an outside agency for any student having severe disabilities
- Mini-authoring software which can be authored or customized to meet individual student needs
- Teacher and student learning styles
- Multiple intelligences
- Whole language

- Alternative/authentic assessment
- Cooperative learning
- "Brain-based" and "Accelerated" learning
- Adapted access to the computer to accommodate the multiple needs and intelligences of students

The Center received an Apple Education Leadership grant for the 1993-1994 school year entitled Inclusion with Technology: The Power of Diversity. This grant has enabled nineteen of Boston's exemplary regular and special education teachers involved in the inclusion of students with disabilities to explore and expand upon the "Hot Tips for Inclusion with Technology." Using Macintosh computers in their classrooms, the teachers are investigating approaches listed above, as well as other areas of interest to them.

In addition, the Center is collaborating with CAST, Inc. of Peabody, MA on the Equal Access Model Inclusion Project at the Harvard-Kent Elementary School in Charlestown, MA. This project will be expanding to other schools in Boston which are involved in the Superintendent's Implementation Plan for Inclusion. In this project computers are serving as a catalyst for changing the attitudes and approaches of teachers in inclusive settings.

Project (M3-308B)

Enhancing Learning with Technology: Fitting the Toy to the Task!

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Key words: student learning, computer technology, classroom integrating, cognitive processes

Abstract

As computer technologies become more prevalent in schools, it is essential that educators harness the capabilities of the technologies to enhance student learning in all subject areas. Currently, national surveys show that computer technologies are not used extensively to enhance instruction. Rather they are used mostly for computer programming and literacy classes—that is to teach students about computers!

Integrating technology into classroom instruction is not a simple task. Teachers need training on how technology can be used to support the cognitive processes students use when they learn. With a grant funded by VQUEST, the initiative to reform mathematics and science education in Virginia, a simple paradigms developed that links the implementation of technologies to the cognitive theories about how students learn. The paradigm provides practitioners with four checkpoints to consider when planning and evaluating implementations of computer technologies in subject areas. The checkpoints are used to evaluate if technologies are being used to:

- expose students to multiple variations of new concepts
- increase student productivity
- engage students at higher levels of Bloom's Taxonomy
- actively involve students in the learning process

Using the materials developed for a series of seminars for Virginia educators, the presentation will provide an overview of the paradigm which can be used for all grade levels and subject areas. The presentation is aimed at division/building level administrators and key teachers who are actively involved in deciding how technology will be used in their school divisions.

Project (M3-308C)

Electronic Performance Support Systems as Electronic Texts

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Key words: electronic performance support, performance support systems, instructional design, electronic text

Abstract

This project describes the utilization of electronic performance support systems (EPSSs) as tools in graduate courses in instructional design and evaluation at two universities, The University of Georgia in the USA and Edith Cowan University in Australia. Electronic performance support tools are one of the primary applications of computers in many fields including engineering (e.g., CAD/CAM systems), medicine (e.g., medical diagnosis systems), and management (e.g., decision support systems) (Gery, 1991). EPSSs are a special type of computerized support system that integrates a knowledge base with practical tools required for a specific type of job. Some EPSSs even include aspects of expert systems, such as decision support.

Body

A comprehensive EPSS might contain three major components, 1) an information base, 2) a set of productivity tools, and 3) decision support programs. In recent years, there have been efforts to develop performance support systems for instructional designers, especially for designers who produce training for business, industry, government, and the military (Merrill, 1990). In one sense, instructional design (ID) EPSSs are extensions of the many and varied tools that instructional designers use in their everyday work. A functionally useful ID EPSS should enhance any of these everyday tools that can be improved upon within a computerized environment. For example, an ID EPSS might include project management software because such software, properly used, is more powerful than the printed calendars and hand-drawn time lines that instructional designers may have employed in the past.

One of the first large scale EPSSs for professional training developers was *ID Library,* developed for the Training Support Group of Apple Computer (Gustafson & Reeves, 1990). *ID Library* has four major levels, 1) an overall instructional design (ID) model; 2) seven ID functions; 3) activities associated with each function; and 4) tools to complement each activity. A second EPSS, *Evaluator's Toolbox,* was developed specifically focused on integrating information about evaluation with a set of electronic tools to carry out evaluation activities. Both of these EPSSs have been used extensively in three courses at The University of Georgia.

In 1993, the use of *ID Library* and the *Evaluator's Toolbox* was extended to the Department of Computer Education at Edith Cowan University in Perth, Western Australia. The programs are available to students in two courses there.

Our conclusions are as follows:

1. Graduate students generally adopt a businesslike manner with respect to using these EPSSs to assist with their course projects. Since many of these assignments are team-based, students tend to use those functions and tools that correspond to the roles they play on their respective teams, e.g., project manager, instructional designers, or evaluator. They adapt the tools in EPSSs to match their specific needs.

2. Student attitudes are extremely positive toward electronic resources such as the *ID Library.* Students also use a number of traditional text resources.

3. It is difficult to attribute the dramatic improvements observed in the quality of course assignments to the use of the EPSSs alone because many other factors are constantly changing in the learning environment that also affect project quality. However, students and faculty do attribute a significant part of the improvement to the guidance and tools they find in the EPSSs.

4. There are major areas for improvements in the EPSSs investigated in this study. In particular, their overall design and interactivity can be enhanced to take advantage of improvements in authoring systems.

We feel (as do the students and faculty) that instructional design students should continue to work with EPSSs during their professional preparation. Although the preliminary investigation into the effects of these EPSSs seems generally positive, much additional research and development remains.

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Special Session (M3-310A)

The Star School Program: Results from the Congressionally Mandated Study

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Key words: distance learning, policy, technology, equity, reform, staff development

Abstract

The U.S. Congress enacted the Star Schools Program Assistance Act of 1988 and reauthorized the program in 1991. Federal guidelines for the Star Schools projects include three distinct, and not always compatible, objectives: equalizing educational opportunity, integrating technology with other aspects of educational reform, and developing and demonstrating "cutting-edge" applications of technology. Federal policy, technology use, and staff development were all major contributors to the outcomes of Star Schools projects.

Contributing Factors

During the past decade, new communication delivery technologies have proliferated. The federal government, through the Star Schools Program Assistance Act, has encouraged:

> ...improved instruction in mathematics, science, foreign languages, and other subjects, such as literacy skills and vocational education...to serve underserved populations, including disadvantaged, illiterate, limited-English proficient, and disabled students through distance learning technologies. (Education Acts, Amendments, 1991)

The Office of Educational Research and Improvement (OERI) of the U.S. Department of Education (USED) has provided funding for three successive cycles of two-year Star Schools projects. Congress acknowledged the importance of assessing the program by including a requirement for an evaluation of the Star Schools Program in the 1991 reauthorization. This paper is based on that mandated report to Congress (Tushnet et al., 1993).

Even though communication technologies were primarily targeted for use in school settings, most of the Star Schools projects were organized by institutions or consortiums with limited knowledge of the needs or the environment of the primary users: school personnel and students. In essence, teachers, along with school and district administrators, played a limited role in the creation of Star Schools projects.

Star Schools projects typically transmit whole courses and course supplements, via satellite, for use in school classrooms. Site visits and interviews with project personnel revealed that far fewer classrooms participate in live, interactive broadcasts than anticipated. Estimates of the percentage of classrooms that use Star Schools distance-learning programs on tape range from 50 to 90%. Even at the low end, this pattern constitutes a major deviation from how the program was conceived. This paper focuses on the reasons participants said they used videotape rather than live broadcasts and the issues raised by those reasons.

Star Schools projects provided two types of staff development: (1) Technical assistance to schools on course content and the technology itself, and (2) general staff development on a range of education-related topics. Projects were far more likely to engage in (and were more successful with) project specific staff development than general staff development.

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Special Session (M3-311A)

Practicing What We Preach: New Technology Models for Teacher Preparation

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Key words: pre-service, in-service, professional development, technology, training

Abstract

By the Year 2000, more than 75% of the Nation's teachers will have left teaching. Many school personnel lament the arrival of newly-certified colleagues no better prepared to use technology than their forebears of thirty years ago. Notwithstanding this, the role of pre-service teacher preparation in the development of technology-competent teachers for tomorrow's schools has been insufficiently examined. Therefore, a panel of experts will lead a 90-minute discussion on the relevant policy and practice challenges for teacher education. The audience will help generate content by participating in a

debate designed to identify specific problem elements for future thought and action. To accomplish this, a "concept mapping" software application will be used with a large-screen projection facility. Audience perceptions will be entered as they are raised. Concepts will be displayed, and simultaneously discussed. Results will ***subsequently*** be made available to participants and to the NECC conference organizers.

Overview

This panel presentation will examine the role of teacher preparation' in the advancement of school improvement through technology. The four panelists will discuss the issue from their unique professional perspectives: Federal government, elementary school, USA university faculty, and UK university faculty.

Niki Davis

Dr. Davis will discuss the need to support instructional technology (IT) at all levels of educational policy and practice. Davis observes that such support needs improvement in several countries. Research shows that new teachers are emerging from their pre-service experience inadequately prepared to integrate technology effectively into their own professional repertoires.

Although conditions vary among nations and institutions, certain themes for success are evident. Teachers of teachers need to develop effective technology practices in their own instruction as models for their students to emulate. Accordingly, technology must be infused into the "whole cloth" of teacher preparation, rather than presented as a separate adjunct to it.

Planning, coordination and leadership, linking teacher preparation institutions to school-based teacher mentoring is critical, as is strong support for technology infusion at the highest management levels of all participating institutions. Faculty in teacher preparation institutions themselves need ongoing training and support; otherwise, a key component of school improvement is left unaddressed. Davis urges educators and policy-makers to encourage and back more in-depth qualitative research on this issue.

Kathleen Fulton

Ms. Fulton will describe the U.S. Congress Office of Technology Assessment's (OTA) current work on technology preparation for teachers. She will discuss the status of various federal initiatives impacting local school practice, and outline OTA's latest work on this subject: an analysis of Federal, state and local efforts to upgrade teacher technology skills.

America's schools have invested massively in technology hardware and software. These expenditures have not been matched by investments in pre-service or in-service professional development. As a result, effective classroom use of technology remains elusive. Models of effective use in teacher preparation institutions are rare. Although more information is needed on the factors that promote and inhibit the effective use of technology, evidence supports the notion that teachers need sustained support, assistance, resources and time to develop and maintain appropriate technology skills.

Failure to invest adequately in pre-service and in-service technology support for teachers wastes existing investments in hardware and software, leaves teaching potential untapped, and impoverishes student learning. Since teachers are now expected to participate more fully in instructional decision-making it is important that they be informed and technologically-competent.

Thomas Wheeler

Mr. Wheeler will address the panel topic from an elementary school perspective. He poses the following questions:

- What happens when elementary school teachers suddenly find themselves surrounded by computers?
- What happens when teachers discover that a large number of their students are semi-computer literate and fully Nintendo-literate, and the teachers are not?
- How do teachers gain the necessary skill to cope with this changing teacher environment?
- Can the practical challenges learned from this scenario be applied to the improvement of pre-service teacher education?

As a computer teacher/coordinator, Mr. Wheeler works to resolve these issues in a recently-built K-8 school. There, community linkages have been fostered. Participants include students, teachers, parents, school board, and the local college. Key change elements have been the children, computer access for preparing teachers, pre-service coursework, and practica negotiated with the participating teacher preparation program.

Guiding this problem-solving effort is a need to change the way teachers view technology in their teaching and as a tool for their student's learning. Anticipated outcomes are:

- an identification of necessary computer competencies for teachers,
- a staff development continuum model for technology literacy,
- a distance learning network for participating professionals, and
- participation in a voice mail system among parents, students and teachers.

This scenario has implications for pre-service and in-service teacher preparation in the development of technology competent teachers for the classrooms of today and the schools of tomorrow.

John LeBaron

Dr. LeBaron will examine the relationship between teacher preparation and higher education, where most pre-service activity is housed. He suggests that the academic culture dominating higher education is poorly aligned with the principles of school improvement, and with the prospects for meaningful technology infusion throughout the fabric of pre-service preparation.

While school reformers are calling for professional peer collaboration, attention to multiple learning styles, flexible timetables, and shared decision-making, higher education operates under traditional notions of fixed semesters, academic hierarchies, and one-style-fits-all site-based instructional contact. Faculty achievement is recognized primarily by printed scholarly publication and grantsmanship, not effective teaching. The tenure and promotion criteria of senior faculty are applied to junior colleagues who might otherwise challenge embedded assumptions, and model such non-traditional practices as electronic publishing, electronic course contact and distance delivered instruction.

Pre-service teacher education may be better placed in institutions other than colleges and universities, such as intermediate school service agencies. In such a scenario, higher education would be doing what it does best: research. Teacher preparation would operate in environments more friendly to the needs of self-renewing schools and teachers.

Special Session (M3-312A)

Translating Knowledge into Practice: Special Education, Writing, and Technology

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Key words: special education, disabilities, technology, writing, telecommunications network

Abstract

This special session will describe an innovative approach for translating knowledge about technology use into effective practice. The focus is on the development of writing skills in students with disabilities. The *Dynamic Approach to Change* is being developed by the National Center to Improve Practice (NCIP). The goal of NCIP, a federally funded project of Education Development Center and WGBH Educational Foundation, is to promote change at the school and district level so that practitioners more effectively use technology to improve educational outcomes for students with diverse disabilities. During

the session, we will present two key components of the *Dynamic Approach*: 1) Practice Packages and 2) NCIP InfoNet. The Practice Packages will highlight, through text and a video, exemplary practices in the uses of technology to support and promote writing development. NCIP InfoNet is a comprehensive electronic network that includes a resource library, a bulletin board, and a forum to support action research in schools. We will explain how leaders of change within school districts can become charter members of the *Dynamic Approach to Change*.

Project (M3-313A)

Computer "Literacy" in Undergraduate and Graduate Education

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Key words: computer literacy, undergraduate computing, graduate computing, computer skills

Abstract

Microcomputers have played an increasing role in both schools and homes over the last decade and a half. Little more than 15 years ago, few people had even seen a computer and fewer still knew how to operate one. As microcomputers increasingly entered schools, students received some exposure to computing during their K-12 education.

Body

At the university level, we have made little effort to provide training in the use of computing for all students. In fact, while most college students seem to be able to use a word processor at some minimal level, their skill level is extremely low. Students at both the undergraduate and graduate level simply don't have the skills to make powerful use of the technology to streamline their education. Colleges of Education may well be the place within the University that computing "for the masses" could be taught effectively.

Since microcomputers began to enter schools in the early 1980s, there has been much talk about "Computer Literacy." Many school systems have implemented required "computer" courses, the content of which has evolved over the past ten or so years. However, in much of higher education, the question of what constituted "computer literacy" has not been addressed in as serious or organized manner. Students wanting to learn more about the computer often take entry level computing courses offered by the Computer Science department. More often than not, these courses are aimed at the students planning degrees in a technical field. The result is that students graduating after four years often have not grown beyond the introduction to computing they received in their middle or high school years. Similarly graduate student completing degrees at universities find themselves struggling to complete final theses or dissertations with unfamiliar word processors and few computing skills.

Since colleges and universities are generally fragmented by department, a courses appropriate for all students is seldom offered. Thus it seems that Departments or Colleges of Education might well assume the task of designing courses that are appropriate for all students. Such courses might include

- an undergraduate "skills" course that designed to teach students how to use the components of an integrated package to increase their personal productivity in their day today work as a student. (In the near future such a course might be considered remedial.)
- an undergraduate "survey" course to explore the issues, history, and implications of technology on society.

Traditional "computer literacy" courses have generally included teaching some technology skills. However, the content of such courses also included terminology, computer architecture, and programming concepts. Today such a course should include deeper concepts. For example, the history of printing provides great insights into desktop publishing while a look at the work of Bush and Nelson throws light on today's hypermedia products. Similarly, the use of the computer to empower the student is enlightened by the writings of Papert while books such as Donald Norman's The Design of Everyday Things provide insights into the interaction between human beings and technology.

- a graduate "skills oriented" course design to help students efficiently and effectively prepare master's and doctoral papers using the power of technology;
- a graduate level course focusing on communication using technology that would include in depth use of telecommunications, and introduction to desk top publishing, and practice using desk top presentation;

The structure of these courses would vary—but the fundamental concepts should be the same. Students—undergraduate and graduate—should enter the world of work prepared to use and to think about technology in our society. Colleges of Education are in a unique position to teach people how to learn and teach using technology. Their skills would enhance such courses.

Those attending this session will receive material elaborating the possible content of such courses. This material will be based on the teaching of the author and the restructuring of the College of Education at her University.

Project (M3-313B)

University of Idaho's Classroom 2000-A Showcase of Technology

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Key words: elementary, math, science, technology, staff development, model classroom, curriculum integration

Abstract

High technology in the classroom is important but expensive. A feasible way to begin infusing such technology into the schools is to develop "high-tech" model Classrooms in which teachers and administrators can learn and experiment. The University of Idaho's Coeur d'Alene Center, Colleges of Education and Engineering, Region 1 Public School Districts, NASA Idaho Space Grant Consortium and North Idaho College collaborated to establish a model science, math and technology classroom. This modal classroom of the future has been designated as the University of Idaho's Classroom 2000.

Classroom 2000 provides a look into the 21st century classroom. This classroom was created to provide in-service training for elementary teachers in the areas of math, science and technology. This facility, located on the second floor of the recently completed University of Idaho Coed d'Alene Center, has been designed to serve as-

A. a centralized model public school classroom, with materials and equipment for math, science and technology;

B. a professional training and development center for teachers,

C. a demonstration site for area public school students and patrons;

D. a technology preview and testing center;

E. a collection of laboratory experiences and materials;

F. a concept and curriculum testing facility;

G. a demonstration site for University of Idaho research, teaching and learning.

Classroom 2000 is equipped with the latest moth, science and technology equipment, including the following; a one-way observation window with microphones for teachers to observe student group interaction and a computer center- with over-175 of the latest math and science educational programs for teachers to preview. Also, Classroom 2000 contains a $17,000 multi-scan projector which is capable of projecting any of the following: video microscopes, video editors, any of the computers, the laserdisc players, computerized weather station or satellite down link telecommunications.

This model classroom is not just computers and videos. Students and teachers are surrounded with visual and tactile learning tools, such as models of a solar system, legos, patten blocks and geological land forms. It is a gathering place where students, teachers and school administrators can try out new instruments before purchasing them. A partnership has been developed with the local Coeur d' Alene School District where enrichment students attend four days a week. This opportunity enables administrators and teachers to view the student's interactions with the technology through the one-way viewing mirror.

Using Classroom 2000, the University of Idaho offered in-service coursework that focused on in depth explorations of the resources, identification of effective methodologies and construction of lessons and or units that integrate technology into the math/science curriculum. In-service opportunities included: weekend workshops, one day seminars, vendor presentations, field trips, and one week courses. Responses from the evaluations have indicated that Classroom 2000 has been a catalyst for integrating technology and science elementary curriculum.

Whether you come to teach or observe students, to learn from in-service classes, or to test, compare and implement new technologies, Classroom 2000 is the strongest professional bridge to reaching the fast track of the future. The only limit in this classroom is one's own imagination.

Project (M3-313C)

Revolutionizing the Computer Literacy Curriculum Using Real-World Applications & Multimedia

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Key words: computer literacy, science, multimedia, real-world applications, databases

Abstract

Computer Literacy as it exists today needs to be and is being redefined. Because students are entering middle school and high school with more sophisticated computer skills, current/traditional computer applications courses and business education course curricula are quickly becoming obsolete. New teaching methodologies, such as cooperative learning, activity-based learning, exploratory model of learning, all support the fundamental educational goals of providing our students with opportunities to critically think, to problem solve, and to prepare themselves for employment or a higher-education career. But the current BE, Computer Literacy, and Computer Applications curricula do not provide our students with these fundamentals.

The current paradigm teaches students *isolated* skills in wordprocessing, spreadsheets, and databases, with the majority of time and emphasis spent on wordprocessing. We are proposing a new way to teach computer literacy, whether as a separate course of study or embedded in the science or social science curricula, using ***real-world applications***. The way to approach this is to reverse the computer literacy paradigm. By reversing the paradigm, students learn relational database concepts, spreadsheet concepts, and wordprocessing, in a climate that supports all of the NEW teaching methodologies and also supports the new breed of computer-literate students (without overwhelming them with techno-babble or boring them to death).

By having students work with a real-live database that has sitting on top of it a multimedia interface (video, graphics, audio), they can work with live data, ask questions of the data, explore what the data can tell them, and hypothesize about their findings through the multimedia interface. From this exploration, they learn and about the specific topic of study and about managing information, . The emphasis on managing information is one of the keys to preparing students for a future in higher-ed or employment and the emphasis on managing data differentiates this NEW paradigm from the current. Once the students have explored the data and found answers, they then import their answer tables into a spreadsheet. They learn the ins-and-outs of spreadsheets by manipulating their own answer tables...for example, would a pie chart better represent the data or a bar graph? From here more spreadsheet concepts are introduced, such as statistical analysis, all which pertains to the information they found in the database.

Once they have their graphs completed, they import them into their report in their wordprocessing program, which they use as the reporting vehicle. This process, of reversing the computer literacy model, mimics what Corporate America does everyday. Corporate America manages data, researches data; graphs it, researches it, analyzes it; and then reports it. All of this supports the student opportunities to critically think, problem solve, and learn computer literacy concepts in an integrated approach.

Special Session (M4-BRCA)

Digital Portfolios: A Richer Picture of Student Achievement

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Abstract

Portfolios are gaining popularity as an alternative form of assessing a student's abilities. There is no doubt that portfolios provide greater amounts of information about a student than the traditional transcript of letters and numbers. But how can the portfolio be organized?

In this session, we will demonstrate the "Digital Portfolio:" a multimedia prototype that is at the heart of a research project being conducted by the Coalition of Essential Schools. (The project is funded by IBM, and the primary research sites are Eastern High School of Jefferson County, Kentucky and Thayer High School of Winchester, New Hampshire.)

The portfolio is tied to a strategy of reform called "planning backwards." In this strategy, a school's community answers three questions:

1. Vision: What should a graduate know and be able to do?
2. Exhibitions: What should a student have to do in order to demonstrate that he or she has those skills and knowledge?
3. Rewiring: How should a school arrange its systems so that all students can reach the mastery required for the exhibitions?

We will discuss how Eastern High School used technology (and specifically, the Digital Portfolio) to enhance the process of planning backwards. We will discuss the technical and logistical requirements for putting the Digital Portfolio in place, the implications for schools in the midst of change, and what it means for kids.

Special Session (M4-BRCB)

Video in the Aid of Assessment

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Abstract

There are three media available to most schools today to aid in the assessment of student work: computers, video, and paper and pencil. Each medium can add a different perspective; here, we will examine what video can and cannot do for the process of assessment.

The Center for Children and Technology has been using videotape to record student work in a number of New York City schools. Video has been used to capture both the development and the final presentation of student work; the resulting tape can become part of a student record. Video need not be used solely for capturing work done in other media; it may also be used as the medium of presentation for original student work.

In this session, we will look at video records of student work, and consider how one might assess the work. What does the video do to the work? How is assessing the video record different from assessing a live presentation? What does the medium add or detract from our understanding of a student's abilities?

Paper (M4-201A)

The Capstone of the C.S. Major

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Key words: undergraduate research, ethics, comprehensive examination

Abstract

A course different from the norm is used to "cap" the undergraduate major. Students are required to present results of their research covering upper-level topics in computer science. Ethics exercises and a comprehensive examination are a significant part of this experience.

Background

In 1987, the faculty of the University of South Carolina at Spartanburg (USCS) passed a general education curricula that requires each baccalaureate major to provide a Senior Seminar course. The format of the course was open to interpretation by the faculty in each major area. It was decided by the computer science faculty that something other than an "ordinary" course would be appropriate. As a result, a research and presentation format was adopted. Over the years, the format has evolved to the present day course described below.

The course syllabus is as follows:

	Grade Each		Final Grade
A-Talk (20 minutes)	100		
A-Paper	100	average to	100
B-Talk (45 minutes)	100		
B-Paper	100	average to	100
C-Talk (45 minutes)	100		
C-Paper	100	average to	100
Programming Exercise			100
Computer Science Fiction Book Report			50
Distinguished Lecture Series Video Report			
Two at	25 points each		50
Ethics in America Video Report			
Two at	25 points each		50
Comprehensive Examination			200
Ethics Self-Assessment Procedure questions:			
4 different at	50 points each		200
		Course Total	950

Rationale

Since the Senior Seminar course was identified as a separate category in the general education curriculum, it seemed that the course should not be the same classroom format as all of the other courses in the major. It could have been treated as a very advanced undergraduate course in which a topic of interest to the instructor is selected. Indeed, other major areas are treating this course in this manner. This methodology does not provide the student with as valuable an experience as requiring them to perform research and give speeches regarding this research.

A major precaution given the participants is that simple lectures belaboring material that they have covered in courses they have taken is not acceptable. The intent is that they may use their course work as a starting point to research areas that are not covered in these previous courses. Another warning is that unless the circumstances are very unusual, each presentation and paper must cover different subject areas. Only rarely has permission been given to have two presentations cover the same primary subject area; and this was generally to permit the introduction of a topic not covered in the curriculum, e.g. programming real-time system controllers, followed later by a long talk relating more advanced aspects.

The Presentations

All student presentations are timed. Presenters are required to deliver one twenty minute talk and two forty-five minute talks. They are penalized for not fulfilling their time requirements. Class periods are normally 50 minutes, so there is an intent to elicit questions at the end of the presentation.

They are permitted to use any audio-visual aids that they see fit. However, if they spend too much time on video tapes, they are penalized for time, just as though they didn't speak long enough. This is a judgment decision by the instructor.

A calendar is given to the students at the beginning of the semester showing the dates of all talks. The talks are indicated as A1, A2, ..., A12 (for a class of 12 students); B1, B2, ..., B12; and C1, C2, ..., C12 on the calendar. The students randomly draw pieces of paper for each talk category to ascertain when their "turn" is. Each talk is drawn separately. The only difficulty with this is that it is possible for a student to have two talks relatively close together. The only circumstance where they are allowed to throw the selection back is if they draw back-to-back talks, e.g., say A12 and B1. These are essentially back-to-back even though there may be other activities between the actual presentation days.

The "A" talk consists of one twenty minute talk. Two students can make these presentations in one class period. The idea here is to get them started doing research on a topic and presenting their results without having an overwhelming amount of preparation. This is a "practice run" in that it is graded somewhat leniently. At the completion of the talk, the speaker is required to turn in a research paper from which the talk was drawn.

The "B" and "C" talks consists of two forty-five minute presentations. This requires extensive research on their part. Since this activity is something the students do infrequently, it initially requires a great deal of time and effort on their part. The intent of the course is to introduce them to intense research, report writing, and presentation. At the completion of each talk, the speaker is required to turn in a research paper from which the talk was drawn.

All of the students enrolled in the course are required to fill out an evaluation form for each talk. A copy of the form is shown as Appendix A. If any visitors come to the talk, they are permitted to fill out an evaluation form if they would like. To ensure that the speaker doesn't bring a large number of friends solely to give high marks on the talk, a formula is used to weigh the students' and visitors' evaluation marks against the instructor's evaluation marks. Currently two scores, the average of all of the student and visitor evaluations and the instructor's evaluation, are used in a weighted formula to produce the final grade for the talk.

Both the papers and the presentations are graded on a one hundred point scale. Then the grades for the presentation and for the paper are averaged together to produce a one hundred point basis for that endeavor.

Science Fiction Books

There is a genre of science fiction works in which the computer is a central part. It was felt that having the students read at least two books would provide a different viewpoint than they will get in their course work. The suggested reading list is provided as Appendix E. Many students do not read works of fiction today, so perhaps this introduces them to another form of entertainment.

Two days are usually set aside during which the science fiction books are discussed. All students must state which books they read. Then, each student gives a brief summary of the book(s) that she or he read. The intent is to have an open discussion about the possibilities of computers becoming "intelligent", or taking over the world, or whatever topic is of interest to the group.

A written book report is required of each of the students. They may report on one or both of the books. The book reports are usually only graded for truthfulness, grammar, syntax, and spelling. The essence of this is that they are permitted to report on their perspective of the book(s), not what the instructor expects to hear about the book(s). No particular book report format is required.

C.S. Distinguished Lecture Video Tapes

The Distinguished Lecture Series[2] of videotapes is a superlative collection of videotapes related to "Forward thinking and development" of topics related to computer science. Each tape has a single theme, and the speaker describes details about her/his topic. The students are required to view at least two video tapes and to produce a written report on each tape. The format for the report is seen in Appendix B. They are encouraged to view these tapes as soon as they can. The tapes have proven to be good resource material for their presentations and papers. The students report on their perspectives of what they have viewed. The written reports are graded for syntax, grammar, and spelling.

Ethics In America Video Tapes

All computer science majors at USCS are required to take a junior level ethics course offered by the philosophy department as part of their general education requirements. Several years ago, PBS ran a series of panel discussions entitled "Ethics in America"[1]. These eleven discussions are available on videotape in the USCS library. To supplement their ethics training, the senior seminar students are required to view at least two of these videotapes and produce a written report on each of them. The students have raved about this videotape series. Often, they state that they have viewed three or four of the tapes. None of the topics relate to computer science; they do relate, however, to real world scenarios, and consequently they are extraordinarily interesting. The students report on their perspectives of what they have viewed. The written reports are graded for syntax, grammar, and spelling. The report format is the same as for the other videotape requirement and is seen in Appendix B.

Ethics Self-Assessments

In November 1990 CACM [4] ran a "Self-Assessment Procedure" related to ethics and ethical considerations in the computer environment. Fifteen scenarios are available along with panel responses. The students are not informed that these scenarios are available in CACM [4]. The intent is that they work the ethics issues out themselves.

Four different scenarios are given to the students as a take-home exercise. The written reports from the students must follow the format given in Appendix C. These exercises are graded leniently, with points being deducted for syntax, grammar, and spelling. These are used as a continuation of the student's ethics training with an emphasis on the relationship of ethics to the computer industry.

Programming Exercise

One of the goals of the computer science major is to produce graduates who are able to function as commercial programmers (as opposed to sending them to graduate school as another possibility). Consequently, it was felt that each student about to graduate should demonstrate her or his ability to write computer programs.

Impartiality and balance in programming exercise subjects is achieved by having problem statements submitted by the faculty. One of the submitted problems is then agreed upon by the faculty that desire to participate in this exercise (not all faculty choose to participate in this exercise).

To prevent students from spending too much time on the programming exercise, a time limit is established. The programming exercise assignment statement has been given to the students in two ways: as a developed algorithm or as a narrative problem description. Since this is an exercise in programming, the author prefers providing an algorithm. Hence, this truly becomes a "coding" exercise rather than a problem solving exercise. The problem solving comes in the Comprehensive Examination discussed later. Experience has shown that particularly evening students who only take one or two courses per semester find this exercise troublesome. This mostly affects students who have not been enrolled in programming courses recently, or who are not working in a programming environment.

The programming languages permitted for this exercise are Modula-2 (the language used in most courses), C, and Ada. At this time, the only language provided by the campus is Modula-2. If the student uses any other language, she or he must provide it.

Comprehensive Examination

The instruction page for the Comprehensive Examination is shown as Appendix D. This provides for five questions worth forty points each.

The first question, "Simple Algorithms", is given as a "take home" test with an honor system time limit. This embodies problem solving by developing an algorithm. This is a principal aspect of the first course in the major. The second question, "Complex Algorithms", covers materials from the second course in the major. This continues the problem solving and algorithms as well as elementary data structures. The third question, "Data Structures", encompasses all aspects of a formal data structures course.

The topics covered on the other two questions include: "File Management", "Computer Organization & Architecture", "Program Design (Software Engineering)", "Database Management", "Operating Systems", "Programming Languages", "Discrete Mathematics", and "Numerical Analysis." Students in the Applied Math Concentration may take "Discrete Mathematics" or "Numerical Analysis", but not both. All of the questions are created and graded by the computer science or mathematics faculty.

The students use a code name on the answer sheets they write their responses on. Consequently, unless the student has a very unique handwriting, people grading the questions do not know whose test they have. It may or may not make any difference to the faculty, but the students feel that this "blind grading" is better.

Other Aspects of the Course

During the first few weeks of the semester, faculty members are given the opportunity to make presentations to the senior seminar students. The faculty member chooses the topic and makes a formal presentation in a fifty minute period or whatever part of the period they choose to use. This introduces the students to the idea of formal presentations and being able to defend their ideas.

If no faculty or not enough faculty choose to make presentations, then one or more of the Distinguished Lecture Series[2] are shown to the students. If video tapes are shown, the students are not permitted to submit those titles as a tape they have reviewed. The Alan Kay tape, "Doing With Images Makes Symbols" is the first choice when video tapes are used. The second choice has been the Seymour Cray tape "What's All This About Gallium Arsenide?"

The newest facet of the Senior Seminar course is to invite alumni to come to the class. Usually, not more than four alumni are invited to attend a class. They are requested to discuss (briefly) what kind of work they are currently doing, what aspects of their course work at USCS was most beneficial, and what aspects of their course work at USCS was least beneficial. The alumni have provided some useful and interesting insights to the computer science program.

Summary

The Senior Seminar course has become a matter of pride among the computer science faculty and the students that have completed the course. The faculty realize that this course advances the students beyond the level of the majority of other students graduating from USCS. The students perceive a sense of accomplishment.

The programming exercise and the comprehensive examination give excellent feedback to the faculty on weaknesses in the curriculum. They also show strengths in the major. This information is used as the primary component of assessment reporting currently required at this institution. Weaknesses are reported along with proposed changes to make the curriculum better. Strengths are reported praising the accomplishments of the students and the faculty.

Upon completion of such a rigorous course, the students will better know what their strong and weak points are. In the job interview process, they can emphasize their strong points and attempt to correct their weak points.

When students ask questions in class, they are attempting to clarify an area that they do not understand. When they have to make complete presentations that are coherent, meaningful, technical, and interesting, they are going way beyond what they normally do in class. In addition, they discover a great deal about themselves.

This experience provides a sense of achievement that just "taking a course" can never provide. Their sense of self-esteem at having successfully completed this course is evident near the end of the semester. It is even more conspicuous for students who must return in the Fall Semester to fulfill other course requirements. Their comments to students often take the tone of one who has been initiated versus one who has not.

Acknowledgements

I would like to thank all of my colleagues who, over several years, have aided me in refining this course to the point where it is today. Just mentioning something that I would like to do to change the course brought insightful suggestions to improve the initial idea. I would particularly thank Barry Parris for his careful review of this paper. I would also like to thank Dr. Andy Crosland for his review of the final version of this paper.

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Paper (M4-201B)

HyperGLOB/Freedom: Preparing Student Designers For a New Media

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Key words: interactive multimedia, hypermedia, graphic design, art

Abstract

Having been born into the computer age, today's students will soon be using a full range of multimedia and interactive capabilities to compose, communicate, and illustrate their ideas just as easily as typing or writing a string of words on paper.

The HyperGLOB project introduced university-level graphic design students to a marriage of computers and communication technologies known as "interactive multimedia." This technology allows designers to use the personal computer to display and manipulate a variety of electronic media simultaneously, combining elements of text and speech, music and sound, still-images, motion video and animated graphics. This new media also allows the eventual "viewers" interactive control—a means to determine their own pathways through the material.

The task of each student was to document or express the concept freedom. The topics selected by students covered a variety of issues: personal and philosophic, restrictions on freedom, social bias, institutional factors, political aspects, and so on.

The HyperGLOB project required students to work in a collective and collaborative mode, as well as individually. Each student established a hypermedia link between their individual stack and two stacks designed by other students. The final result was a large network of convergent ideas (assembled into 30+ megabytes of disk space) which suggested the name: HyperGLOB.

"We know that where we perceive no patterns of relationship, no design, we discover no meaning. If the items of information we acquire from news broadcasts, books, and other sources lie around in our minds, unrelated to one another and to our everyday experience, they constitute a pointless and boring miscellany." John Kouwenhoven (1982, p. 208).

Introduction

In addition to news broadcasts or books, information that is digitally processed and delivered via computers is rapidly becoming a common part of our worldwide twenty-first century techno-culture. Today, the medium for instruction, communication and creative work with computers is increasingly multi-sensory—delivering ideas through images, video, sound as well as text.

For printed materials, the responsibility for "constructing communication" has in some part been the domain of graphic designers—the professionals who direct the shape and organization of communications through the careful selection of color, typography, images and other visual characteristics. Like a film director, the designer is invisible and anonymous, yet permeates every nuance of a project. In our daily lives, we are surrounded by the familiar products of graphic designers which might include posters, corporate logomarks, news graphics, magazines, packaging, or signage.

This paper describes a project where university-level graphic design students were introduced to computers that they will later use as professionals to produce conventional printed materials. The HyperGLOB project, however, challenges the students to design a document in the new totally-digital computer-based environment—interactive multimedia—and to apply their concerns for human factors (perception, interpretation, understanding) not to a printed page, but to a computer screen.

Interactive Multimedia

In the middle of this century, electronic media (television) joined paper-based media (printed text and images) as a useful tool for communication, learning and entertainment. In only the past decade, personal computers have entered and transformed these earlier media into a new configuration which has been recently popularized as the "information superhighway."

Perhaps the most comprehensive and complete term for the eventual marriage of computers and communication technologies is "interactive multimedia"—which incorporates its two vital characteristics. "Interactive" suggests the ability of the "viewer" to control the sequence and structure of their experience in the electronic media environment—to determine their own pathways through the material. The best examples of interactivity exploit the "digital" decision-making possibilities of the computer. On the other hand, the most limited uses resemble only a computerized sequential slideshow. The term "multimedia" describes the use of a personal computer to compose, display and manipulate a variety of electronic media simultaneously, combining elements of text and speech, music and sound, still-images, motion video and animated graphics.

For this project, student designers used Apple Macintosh IIcx computers with the software application *HyperCard* (Claris) to design and build a set of interactive multimedia documents. *HyperCard* is a simple software toolkit for the Apple Macintosh computer that allows users to build their own interactive documents (called stacks). The primary function of

HyperCard is to interlink a group of computer screens (called cards) with on-screen "buttons" that can be operated by clicking with a computer mouse.

Project Details

The HyperGLOB project was composed of three phases: an introduction, individual work, and connective work. To orient students to this new media, videotapes of several hypermedia projects were shown and discussed. Other examples were demonstrated during class (see note 1). Next, the students were instructed to design a short *HyperCard* exercise to explore the fundamental operations that they would use to build their larger stacks. After these activities, students spent several more weeks researching, planning, and producing their work.

The core subject matter for the larger HyperGLOB project was the concept freedom. Each student chose a specific topic of interest associated with this broad concept. Their task was to document, to describe, to express, to educate, to a viewer something about that aspect of freedom. Students were cautioned not to become quickly distracted by ideals of American democracy or simple visual symbols of freedom (like an American flag). The topics finally selected by students covered a variety of issues: personal (marriage, family), restrictions on freedom (justice, death penalty), social bias (racism, censorship), institutional factors (religion, state, education), political aspects (Arab-Israeli conflict, Berlin Wall), and so on.

After completing their individual stacks, the final phase of the HyperGLOB project required students to work in a collective and collaborative mode. Each student was asked to establish a hypermedia link between their individual stack and two stacks designed by other students. To accomplish this, they developed an intermediate series of cards to act as an intellectual and visual bridge between ideas, trying to create a seamless continuity. The challenge of this phase was to exploit the potential of *HyperCard* for building non-linear sequences of ideas that branch and interconnect. The final result (see note 2) was a large network of convergent ideas (assembled into 30+ megabytes of disk space) which suggested the name: HyperGLOB.

The HyperGLOB project demonstrates that an advanced computer system is not needed to begin exploring the fundamentals of interactive multimedia, and that with the user-friendly software program *HyperCard*, novice students can quickly produce sophisticated projects working individually or in teams. Also, the basic methods are easily transferable to any subject matter or academic level and can engage individual students or the class as a whole.

One student, after working to integrate his stack with others, observed that, "People have totally different ways of laying out their ideas than the way you lay out yours. Different type styles, images, cropping, even the vocabulary is different." This statement contains the essence of the HyperGLOB project. By working to integrate their individual stacks (both visually and intellectually) with the larger group, students struggled with the same dynamics present in many other situations, such as the responsibilities of the individual to society.

The Issue of Freedom

Freedom is an enduring human question. The modern notion of naturally-endowed freedoms can be traced to the thinkers of the French Enlightenment and the American Revolution (Rousseau, 1984; Paine, 1921). They philosophize that the world, in its natural state, is a chaotic and savage place. In such a world, you are free to exercise any of the abilities endowed to you as a human being. For example, you are absolutely enabled to reap destruction upon your neighbor. However, if you do not want your neighbors to execute their equal ability of destruction upon you, you can construct a pact—or in Rousseau's term, a social contract. To gain security and order, you must sacrifice some primal aspect of your being. Every right is balanced with a corresponding responsibility.

One modern example is our system of traffic signals. There is no actual barrier to driving your car speeding through a red light. What prevents you is a system of social constructs, derived from a desire for self-preservation and personal security. You gladly sacrifice your original ability to drive wherever and whenever you want for some guarantee that others will do the same. The question of freedom—personal expression versus common cause—is encountered and resolved by everyone in a multitude of everyday decisions.

By addressing the general question of freedom, the HyperGLOB project provokes students to consider parallel ideas about the relationship of freedom to the underlying nature of hypermedia, to the practice of graphic design, and finally to their own lives.

The nature of hypermedia itself demands interactivity—flexibility within structure, non-linearity, and choice. Like the dynamic balance of rights and responsibilities, a complete lack of structure will result in chaos—a glut of randomly-distributed and fragmented ideas rather than a larger body of useful knowledge. In contrast, too much programmed structure yields continuous but predetermined patterns.

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This question of freedom is also a relevant philosophic issue for graphic designers. The fundamental challenge of graphic design is creativity within compromise. Unlike the fine artist who exhibits artwork framed and purified from the world in a white-walled gallery, the graphic designer must incorporate their work with, not abstract it from, the context of the world. To design a corporate logomark, for example, that does not consider other competitor's symbols or the intended audience is not good design. Like the social contract between the individual and society, graphic designers must be able to establish compromise with their client—creativity within context.

Finally, the students themselves are in a stage of personal transition. They are seeking and establishing a new structure for their lives as adults, independent from parents and the security of home. Perhaps the HyperGLOB project can slightly stir into consciousness some latent awareness of these problems of freedom and connect to the personal experiences of the students.

Design Factors and Observations

As with any design project, the final critique is a time of critical review where common problems are clarified and individual innovation is highlighted. The HyperGLOB project review reaffirmed several visual design principles:

- The basic formal principles of design (like balance, pattern, proportion) still apply to composition of a computer screen. For example, information should not be stuffed onto a card from "wall-to-wall." Sometimes the negative space of a composition is as useful as the positive space to create dramatic images.

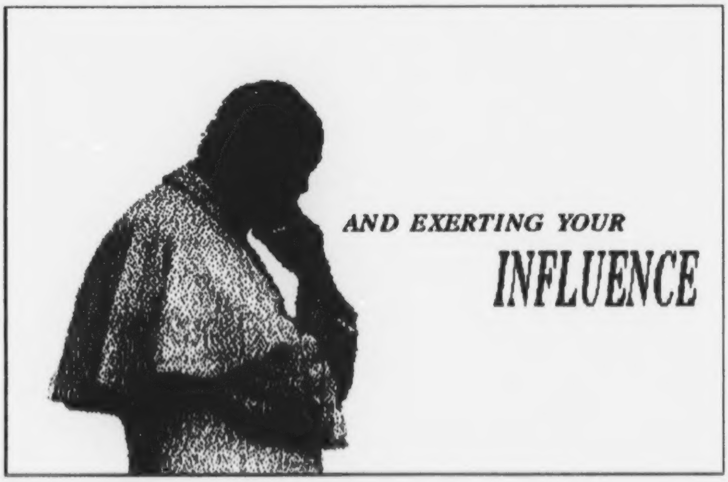


Figure 1. An example of "active" white space. (Scott Gerber).

- Attention to typography, the arrangement of letterforms for expression and organization, also remains a factor. Although the computer screen does not hold the same quality and resolution as a printed page, this should not distract the designer from demanding well-spaced typography within the limits of the video display. Computers do not automatically place and space letters equally without error. Proper letterspacing must finally be judged by the human eye, not numerical measurements.

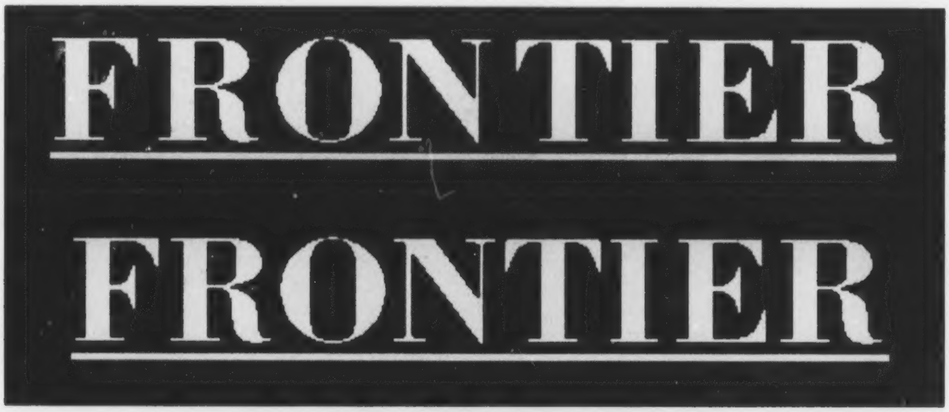
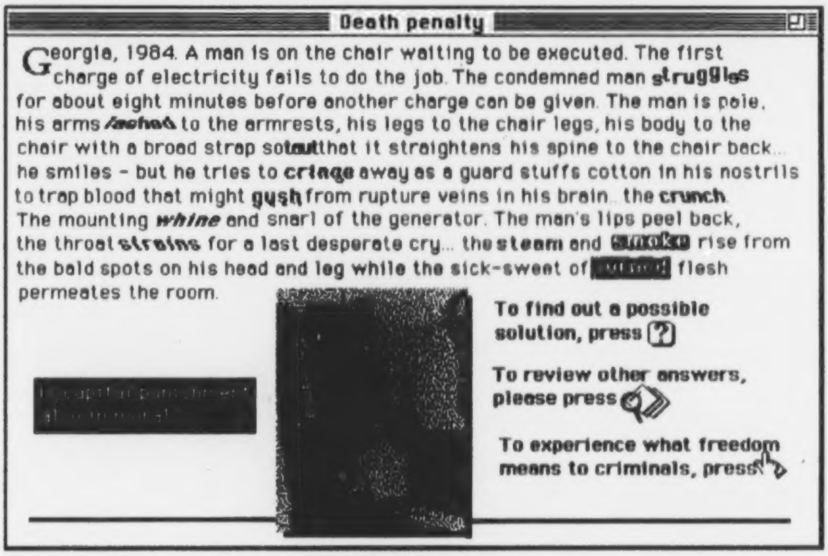


Figure 2. Typographic details are important. Notice the gap between the N and T, and the improved letterspace below.

- The amount of text on any one screen should be limited to short simple phrases. Due to the low resolution of the computer display, small letters break apart and become illegible. Moreover, users interact at a pace too rapid for reading—a pace closely related to watching television where communication occurs instantaneously through images and sounds.



Georgia, 1984. A man is on the chair waiting to be executed. The first charge of electricity fails to do the job. The condemned man struggles for about eight minutes before another charge can be given. The man is pale, his arms lashed to the armrests, his legs to the chair legs, his body to the chair with a broad strap so taut that it straightens his spine to the chair back... he smiles - but he tries to cringe away as a guard stuffs cotton in his nostrils to trap blood that might gush from rupture veins in his brain... the crunch. The mounting whine and snarl of the generator. The man's lips peel back, the throat strains for a last desperate cry... the steam and smoke rise from the bald spots on his head and leg while the sick-sweet of [illegible] flesh permeates the room.

To find out a possible solution, press ?

To review other answers, please press

To experience what freedom means to criminals, press

Figure 3. Excessive text can be hard to read. Can it instead be expressed with sound or images? (Jorge Naranjo).

Multimedia

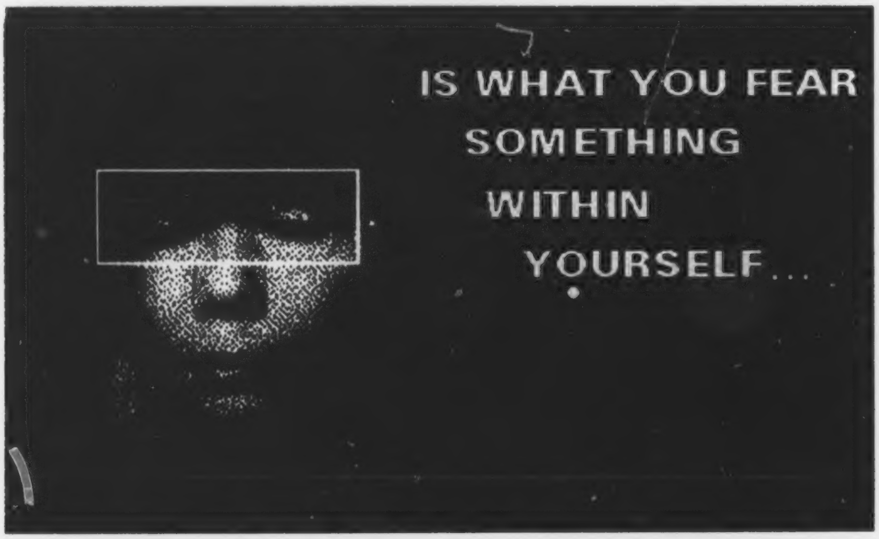
In this new media, ideas can be expressed using a variety of sensory and cognitive modes: text, drawings, photographic images, animation, sounds, voice, music, or any combination thereof. Good "multimedia" will take advantage of the inherent qualities of each mode to more completely express an idea or concept.

For example, a tea kettle can be more robustly understood not only through its image, but also through a few clearly recognizable sounds—the whistle, or the clang of the metal container. Sometimes sound is simply used to develop context—a general atmosphere. In one student *HyperCard* stack, synchronized sound is used to punctuate a sequence of animation and later a deep grinding pulse is used to reflect the industrial rhythm of machinery, power, and infrastructure, which all relate to the content of the stack.

Graphic designers seem particularly suited for tasks, like creating multimedia, that involve the integration of various elements. Essential to their practice, even in the design of printed material, is a close interrelationship between word and image (verbal and visual modes of communication).

Interactivity and Structure

In *HyperCard*, buttons are the active areas of the screen that allow the user to jump from card to card by clicking on them with a mouse. Students demonstrated two strategies for interfacing buttons to cards. One strategy has the buttons clearly set apart from the background images, like the controls on television set. The second strategy is to locate the button transparently within the images of the card and position them according to concentrated areas of attention. The composition of the card usually suggests one or two visually-logical focal points.



IS WHAT YOU FEAR
SOMETHING
WITHIN
YOURSELF...

Figure 4. The eyes are a visually logical button position. (Christy Vaughan).

While using buttons to move through a series of cards, the user should develop a sense of continuity between cards, not the sense of a disconnected and fractured pathway. Students echoed visual elements from card to card, and carefully programmed visual transitions to respond to the visual composition of a screen. For example, a card containing the image of a landscape would blend to the next card with a horizontal transition effect.

To outline the sequence and structure of their stacks, many students first sketched a diagram that resembled a flowchart or a movie storyboard. The underlying pathways of individual stacks were arranged in a variety of structures: one central card with spokes radiating to other cards like a wheel, or a main trunk and branches like a tree, and some were nearly straight linear slideshows—an uninterrupted sequence of cards with little user control.

Educational Objectives

The technical goal of the HyperGLOB project was to introduce novice students to simple Macintosh computer operating skills (e.g. cut, paste, save) and basic graphics ideas (e.g. bitmap painting, importing graphics, scanning) that will transfer to other class projects.

A higher-order goal of the project, as noted previously, was to stimulate thinking about the concept of freedom and its relationship to hypermedia, design, and the personal lives of the students.

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Finally, the HyperGLOB project was able to engage students in a constructive and collaborative system of classroom learning where individual expression becomes nested in a larger network of ideas. This simulates the professional challenges that they will encounter as practicing designers in our society.

HyperGLOB Examples

The following examples describe several of the individual stacks produced by students, and are accompanied by illustrations.

- Decisions (Tracy McCotter): This stack examines the social influences that shape our individual decisions—friends, government, society, family, and even your pet dog. If the user tries to escape these "outside influences" then a digitized voice of Orwellian tone proclaims: "It is useless to resist us."

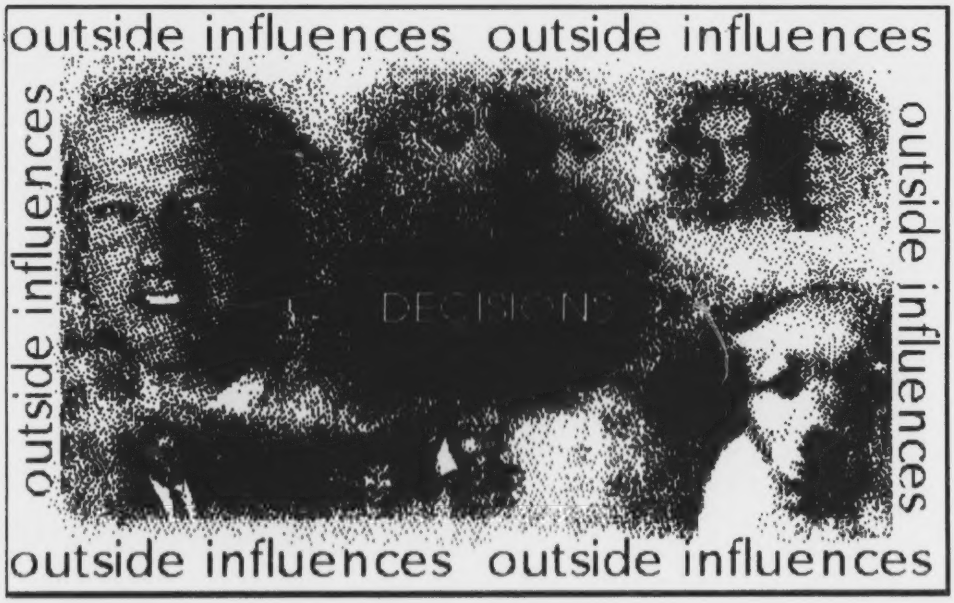
outside influences outside influences
outside influences
outside influences
DECISIONS
outside influences outside influences

Figure 5. Tracy McCotter.

- Religion (Elizabeth Montgomery): Reacting to the personal experience of growing up in a combined Jewish and Christian household, this student questions how we come to acquire our particular religious faiths. Her stack associates imagery from modern-day evangelism to ancient rites.

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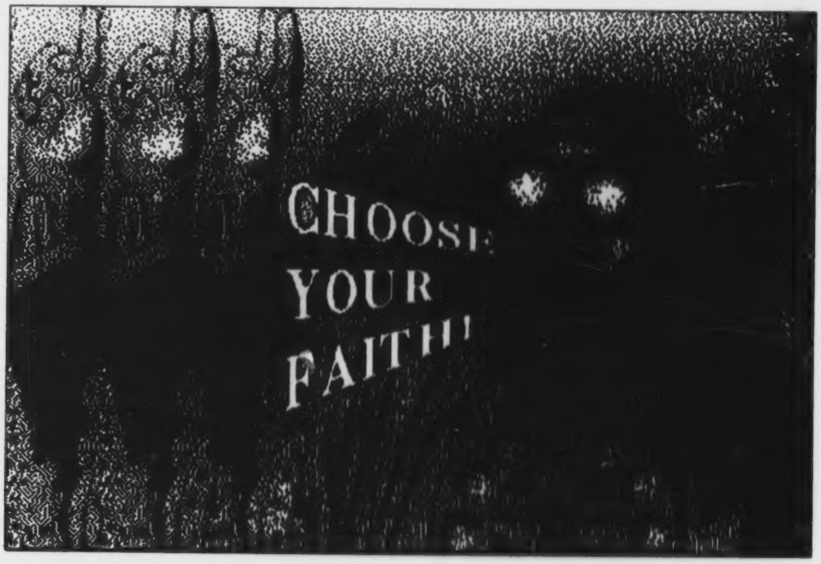

Figure 6. Elizabeth Montgomery.

- Details (Juli Summers): By interacting with a street scene of store-front windows, the user can browse through a world of funky fashion and expressive styles. After clicking on a doorway, the user can enter and browse through a series of shops like Cucorachas, a good-time coffeehouse infested by one giant cockroach.

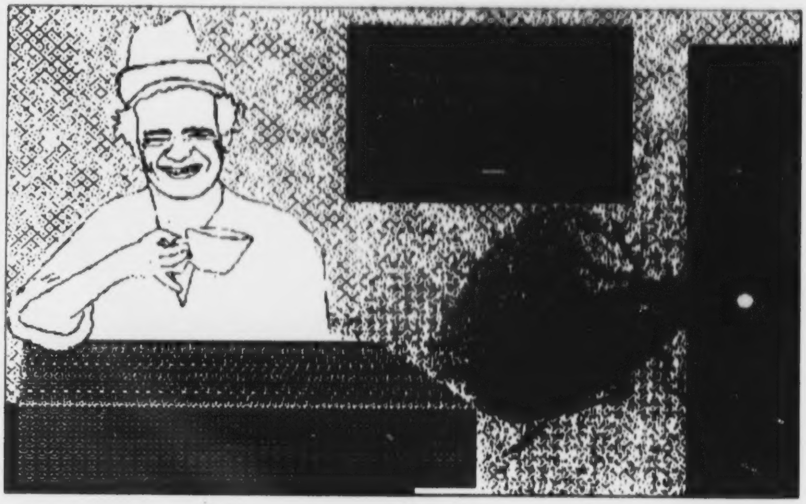

Figure 7. Juli Summers.

Conclusion

One student remarked that the most interesting aspect of the HyperGLOB project was "...being introduced to something so contemporary, almost a taste of the future." These students, having been born into the computer age and not adopted by it, can sense the coming revolutionary merger of technology, communication and culture that will occur during their generation. By the time these students become active citizens, the technologies of voice recognition, pen-based computing, intelligent systems, virtual reality simulations, cooperative telecomputing will be the norm.

As the digital web of world-wide information expands, with clusters connecting and layers building, some design students may recognize that the shape of the new media network resembles their HyperGLOB project. In turn, their investigations with HyperGLOB on a smaller scale may suggest what strategies to maintain from their old ways of working in print design, and what new challenges they must overcome as the constructors of a new communications environment.

These students will become the practicing professionals of the twenty-first century. How we nurture their intelligence, vision, and design sense in our classrooms today, will determine if they compose something more than "...a pointless and boring miscellany..." from the elements of this new media.

Note 1. Examples from an older version of the HyperGLOB project were shown on videotape to the students. This older project took human communication, not freedom, as the core subject matter. Also shown was A Memory Project by Henry See, a Canadian hypermedia artist. Hands-on examples included two hypermedia project stored on CD-ROM: Beethoven's Fifth Symphony (Voyager), and Cosmic Osmo (Cyan).

Note 2. After connecting of the first mass of *HyperCard* stacks into a HyperGLOB, the project was repeated with another group of students who were required to integrate their work with the students from the earlier semester. Thus, the HyperGLOB project continued to grow into an even greater interwoven network responding to the core idea of freedom.

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Paper (M4-202A)

Telecommunications: From the Physics Forum to SpaceMet to UMassK12

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Abstract

The PC based Physics Forum bulletin board started in 1986 led to the SpaceMet network and the UMassK12 Internet service. The menu-driven UMassK12 system supports 100 concurrent callers; daily usage went from 100 to 700+ calls in 6 months. Teacher training and support have been critical. Dial-up locations around the state make access free or inexpensive. A leased line to Franklin County Tech School provides Internet access via its LAN and dial-up lines.

Introduction

We have been involved with educational bulletin boards (bbs) since 1986. The original PC based bbs, the Physics Forum, evolved into the SpaceMet bbs network. A new system, UMassK12, provides full Internet services for Massachusetts

K12 educators and students. We will describe the growth and characteristics of these systems and also address issues of training and access.

The Physics Forum

When the University of Massachusetts announced a small telecommunications grant program, we proposed starting a bbs for Massachusetts high school physics teachers. Physics teachers are generally isolated and often poorly trained, and we hoped to bring them the resources of UMass and of the teaching community. Operation began in May, 1986, with an AT clone running Fido software in two multitasking (DesqView) windows. Access was available via a local phone number, an 800 number, and a leased line from the Boston campus, 100 miles away.

The Physics Forum was an excellent bbs, with conferences devoted to science, education, computers, and related areas, with and collections of physics teaching materials. However, despite extensive publicity, usage was far less than we had anticipated—a few calls per day.

Physics teachers had limited access to computers and telephones; modems were an expensive novelty. Given the logistical problems and the full daytime schedule teachers faced, the low level of utilization was understandable. In fact, just about every other educational bbs venture started then had a similar experience. Soon we welcomed all teachers and students interested in science or computers. We publicized the system using teacher newsletters and spoke at conferences and workshops. Gradually usage grew.

SpaceMet

In 1989, the National Science Foundation awarded the SpaceMet middle school science teaching enhancement grant to the Five Colleges/Western Massachusetts Partnership, which links area schools and Amherst, Hampshire, Mount Holyoke and Smith Colleges and the University of Massachusetts. SpaceMet helped middle school science teachers to use space exploration to interest students in science and technology. The Physics Forum became the SpaceMet network of three 386's running Maximus bbs software under DesqView. Each computer had two to four phone lines, and they were located to provide local phone call access to nearly all of our project participants and their classes; the Boston and 800 line connections were continued.

Messages entered on any SpaceMet bbs "echoed" to the others. Teachers and their students used the system to share ideas and information about the SpaceMet project and also to communicate with their peers elsewhere in the world.

In 1991 we added a 486 with an eight serial port "Digiboard" and connected it via an Emulex terminal server to the Internet. We also placed a half dozen bbs on XT's in classrooms. These allow students to access echoes locally without tying up our ports except during brief mail transfers. The system now has over 3000 users, receives up to 300 daily calls, and is part of the NSF Five College Education in the Earth's Environment, Ecology, and Energy Project (5C/5E).

Anyone is welcome to use SpaceMet Central (413-545-4453) or SpaceMet Internet (spacemet.phast.umass.edu), not just SpaceMet or 5C/5E teachers and their students. This wider community enhances the system and includes many of our most energetic and innovative participants. The echomail connections to teachers and children around the world add an additional dimension to the telecomm experience. There are conferences related to our own NSF projects and other regional teacher and community projects. We have the forty or so echomail areas and project channels of K12Net, a system of 500+ educational bulletin boards, and a selection of FidoNet conferences. (FidoNet links over 25,000 microcomputer based bulletin boards located around the world.) The 3000+ files available for downloading include text files—teaching materials, NASA space and astronomy data, ERIC abstracts, environmental science information—plus educational shareware programs. We have a searchable database based on these documents and on calendars of events, etc.

We have sought throughout to provide a stimulating and varied telecommunications resource to the teachers and students of our area and of Massachusetts. Connections to SpaceMet and UMassK12 are now available via the five campuses of the University, Mount Holyoke College, and several state and community colleges connected to the MassNet network.

SpaceMet Internet

Experienced callers are often surprised to telnet over the Internet to a Maximus bbs and ask how we accomplish this. As noted earlier, users access a Emulex terminal server. This is a $1500 box that looks like a modem to a serial port on our 486. This setup works but has definite limitations. Running 8 or more windows under DesqView, even on a 66 MHz 486, often leads to delayed or jerky responses. Probably a true multiuser bbs program such as TBBS would solve this problem. More serious is the inability of our users to do file transfers over the Internet. ZModem, XModem, etc., all fail more often than not. Only Kermit works reliably over the Internet, and Maximus does not support this protocol.

Terminal servers and multiport boards represent an expensive and clumsy way to bridge the Internet and MS-DOS worlds. Users cannot telnet out of the system to access the riches of the Internet, nor can they use the standard Internet File Transfer Protocol (FTP). Running a pure Internet system instead makes a lot of sense.

Issues in Internet access for K12

We had originally not put our educational telecommunications service on a mainframe or minicomputer because of their generally awful user interfaces. Until recently, nothing comparable to the many excellent microcomputer bbs programs existed for Vaxes and the like. Nevertheless, the lure of the Internet became increasingly hard to resist. We wanted our users to have the opportunity to explore the thousands of public access sites offering an incredible range of information resources, and looked for appropriate ways to make this possible.

In making Internet access available to teachers and students, three key factors must be kept in mind.

- You can't just provide a naked $ or % prompt; teachers and students need help and guidance in locating resources and exploiting the system. A good menu based interface is essential.
- Students cannot be allowed free access to materials considered inappropriate for minors. The organizations providing Internet connectivity are understandably concerned that such access be avoided. A menu based system can control what students may reach and deal with this "social liability" issue. User agreements and parental consent forms are additional safeguards for the providers.
- Schools have limited computer resources; demanding specific terminal capabilities excludes many potential users. A survey of 116 5C/5E project teachers found the following numbers for access to computers at school and at home:

Computers Available to Western Massachusetts Teachers

School	#	%	Home	#	%
IBM/clone	38	33	IBM/clone	29	25
Mac	24	21	Mac	12	10
Apple II	88	76	Apple II	23	20
Other	3	3	Other	5	4
None	2	2	None	47	41

School percentages total more than 100 because of multiple platforms. The Apple II is most common, and half the teachers in the survey had ONLY Apple II's in school. At home, it was IBM or clone, Macintosh, and Apple, in that order, with 59 percent of these teachers having some kind of computer. Clearly, if we require Macintosh or Microsoft Windows user interfaces, we exclude much of our target audience.

The UMassK12 system

The University Computer Services (UCS) agreed to help in creating an Internet bulletin board for Massachusetts K12 educators and students by purchasing a DEC Ultrix workstation, a model 5000/133. This computer has 48 Mb of ram and 3 Gb of disk storage, and can handle 100 concurrent user sessions.

We decided to use the FreePort program developed for Cleveland FreeNet, a popular public access Internet bbs. This software is definitely low tech—you can access it with a dumb terminal—although the message editor and some connections to the outside world such as the gopher service require VT100 emulation. File transfers requires that the terminal also support Kermit. VT100 and Kermit are both provided by many MS-DOS and Macintosh shareware and commercial communications packages, and by one Apple II commercial program, ProTerm.

Inexperienced users find the FreePort layers of menus easy to understand, and go xxxx shortcuts make it efficient for experienced users. The use of similar interfaces for mail and newsgroups is a good feature. The software runs under UNIX, but users do not need to know anything about UNIX except that the commands are often case-sensitive. Our programmer has modified the original FreePort package extensively to run properly under Ultrix and to fit our tastes and needs.

Our Internet bbs, UMassK12 (k12.ucs.umass.edu; login: guest) has been operational since May, 1993. We have held workshops for up to 40 people at once, and the system response has been instant and flawless. Both experienced and novice users find UMassK12 a comfortable environment. ("The best system I've seen" according to one experienced user.) Computer interfaces that are easy to learn do not automatically have enough functionality to allow for ease of use in performing a variety of tasks. We apparently have successfully balanced the two requirements with our simple but logical menus, help screens, manuals, and training materials.

UMassK12 menus

On UMassK12, teachers have full Internet access, while students are limited by the menus to specific sites and functions. The range of services we offer is suggested by the Main Menu:

```
1  User Settings and Information
2  Bulletins
3  Electronic Mail
4  Newsgroups
5  Local Resources
6  UMassK12 Gopher
7  Connections to Other Services
8  Personal Files
9  Help Desk
10  Access Phone Numbers for UMassK12
11  Send Mail to Sysop
```

The first menu choice leads to configuration options, account application forms, and information about the system. Bulletins include announcements of workshops and other local events. Electronic mail provides the usual range of Internet E-mail options, including signature files, aliases, mail forwarding, etc.

Our philosophy is apparent in the Newsgroup option. We carry a substantial fraction of the usenet newsgroup backbone, but include only groups that are appropriate to a school environment. These are grouped logically in menus to facilitate access. We also gate our own SpaceMet echoes and some FidoNet echoes to local newsgroups using the UFGATE program. This links our older SpaceMet network with the new UMassK12 system.

Local Resources allows users access to extensive collections of information about telecommunications, science, and other academic areas. The K12 Gopher is configured so that students can access a wide variety of gopher services, but never reach a menu item offering "All the Gophers in the World." Connections to Other Services guides users to specific telnet sites and also provides teachers full gopher, telnet, and FTP services. Personal Files allows users to upload and download files, edit them, send them to others, etc. Help Desk and Access Numbers provide additional information. Mail to Sysop encourages feedback and asking for assistance.

Training

Teacher support is critical for educational telecommunications. Teachers are not computer hobbyists or professionals. They need training programs, well written manuals and help screens. They need help, on site, on-line, and via telephone, both with the technical aspects of telecommunications and with its effective utilization in the classroom. Anyone planning an educational telecommunications service must budget realistically for this support.

When we obtained our NSF SpaceMet science teacher enhancement grant in 1989, we began formal teacher training in the use of the bbs. After our first year of the SpaceMet project we developed procedures that work well for us. We did one-on-one introductions to telecomm with our project participants in the spring. During the three week summer institute, they completed worksheets covering all the aspects of the system. We continued to provide support during the following year while they worked with their students on the academic year components of the project.

Training for UMassK12 is simplified by its 100 concurrent user capacity which makes it possible to do large workshops using terminal rooms. Worksheets take users through configuring their accounts, bulletins, electronic mail, newsgroups, local resources and gopher. Advanced topics for users with some background (or for a second session) include aliases, signature files, telnet, and FTP. Participants progress at their own pace, asking for help when needed. One staff member per 5-8 participants works well. Given the simplicity of the user interface and the clarity of the manual, even telecommunications neophytes make rapid progress. Approximately 500 teachers have attended workshops up to February, 1994, and the response to the workshops and the system has been extremely positive.

Projects

Local and national or international projects are a key feature of SpaceMet and UMassK12. K12Net projects are available in both systems. UMassK12 also offers Kidlink and other Internet based projects. Western Massachusetts teachers have undertaken local projects with their students sharing stream and weather data and other classroom research information.

It is important to offer guidance in developing applications. Teachers are a great source of ideas, but they often need help in defining realistic telecommunications projects, in locating participants, and in exploiting the technology. Telecommunications projects require a critical mass of people who have agreed to participate, a good leader or facilitator, and a realistic time line. Simple projects which allow flexibility in implementation often work best.

Some examples

The following messages are from various projects that were active last year on our bbs and on others around the world. They illustrate the value of telecommunications in the classroom. The first is from a teacher in our 5C/5E streams research community. Each class tracked characteristics of a local stream and observed its insect life. They shared their data and determined regional patterns.

```
From: Betsy Koscher
To: Ryan Road
Subj: data from stream
__________________________

The class found several caddis fly cases and a stone fly
case. They caught minor water striders and several yet to be
identified bugs... This is our data:
1. date 4/30/93
2. school Chapin Street
3. teacher Mrs. Koscher
4. stream Harris Brook
5. precipitation—none for two days
7. pH stream—7.0
8. Temp air—69F, 20C|
9. Water temp—53F, 12C
10. Nitrates—none present
15. velocity—56r/min
16. hardness—3 mg/g
17. turbidity—light pale clear yellowish green floating sand
here and there
18. discharge—haven't figured it but it was much less than
just last Tuesday when it was 5 inches deeper and 12 r/min
faster. We think it is because it rained last Monday and
didn't rain before Friday.
```

* Origin: SpaceMet South (Holyoke, MA) (1:321/302)

Two junior high classes in the 5C/5E project exchanged write-ups of their independent research projects and then communicated electronically about their findings.

```
From: Hawks Rule
To: FRONTIER THREE
Subj: MEAGAN BARONAS
________________________

The major findings when i did this investigation were that
popsecret popped the fluffiest then jollytime, act 2 lite
natural, act 2 lite butter, and last popquiz. Is this what
you found?
            THANKS, JEN KENNEDY
```

* Origin: SpaceMet-North Greenfield, MA (1:321/152)

Currently we are supporting an unusual intergenerational community based project that links middle school children and elderly people in nursing homes and senior centers. Here is a typical message.

From: Michele Hebert
To: Vi Osborne
Subj: Hello!

Hi! We are Joe, Andrea C., Krystal, and Tony. We love poetry and we hear that you do to! We want you to be our Team Leader. We are looking forward to meeting you soon so... GET WELL SOON. Write back to Liberty School.

K12Net's Global Village News is an example of a very simple project concept that works really well. Moderator Lorna Kropp in , Spokane, Washington asked participants to "post the information about your community and then look for other news and compare the kinds of celebrations. Are there any patterns? Any celebrations dependent on geography, climate or cultural heritage? What other questions can you ask?"

From: Elizabeth Probert
To: Lorna Kropp
Subj: Global Village News

Several class members wanted to tell though of how life is different here in winter so:

Shannon S writes: My life is affected by the sport I do. In summer I compete on my horse in competitions and play summer netball and tennis and go swimming. In winter I play indoor soccer and soccer and do all the winter dressage and show jumping series on my horse....

Rochelle says: School life is different because it is a lot colder and finding a seat at lunchtime is a lot harder as the grounds are wet and everyone is wanting to sit on a bench.

[teacher—in most of NZ, students bring lunch to school or buy it at the Tuckshop. There is no cafeteria though or covered place for eating lunch. If it is wet at lunchtime in our school, students eat lunch in classrooms and we have a short lunchtime and go home a bit earlier.]

The K12Net MathMagic project invites classes to tackle unusual math problems:

From: Chris Riley
To: all
Subj: Mathmagic problem grade 7/8

Our names are Lori Moreno, Chris Riley, Howard Mancillas. We are from Indian Ridge Middle School in El Paso,Texas. A cassette tape has 2 sides A&B. There are 9 songs. The length of each songs are 1)2:30, 2)1:50, 3)4:25, 4)3:25, 5)2:48, 6)3:00, 7)2:27, 8)3:27, 9)4:10. Now we must schedule the songs in the most efficient manner. We must arrange it to use as little tape as possible. There must be 3 seconds of silence between them.

We need to find the total length of minutes & seconds. We need to know what songs are on side A &B to reduce the amount of tape needed. We need to know what is the difference in the amount of time music plays on each side of your arrangement.

For #1 we had to add up the minutes first then we added up all the seconds and divide by 60. To find out what songs

```
were on side A & side B we picked random songs and added
then up to see what was the closest arrangement to 14 min.
We found the closest arrangement which was 14 &14.
```

• Origin: Hawks K12Net, El Paso, (1:381/105)

The Internet-based Kidlink projects annually involved about 10,000 children aged 10-15 in fifty countries. They tell about themselves in a specific format and then take part in activities such as a conference on Children's Rights:

```
From: UBJVM6Q@aster.ccs.bbk.ac.uk (MIKE BURLEIGH)
Subject: *UNICEF Information project: Children's Rights
Date: Sun Sep 12 09:25:00 1993
_________________________

The Castelnau kids from England have been talking about our
idea of children's rights. We think kids all over the world
should have these rights, regardless of race, religion,
physical or mental ability. Here they are:

The right to an education,
The right to clean water,
The right to enough food,
The right to a safe home,
The right to be loved,
The right to say what they feel and be heard,
The right to war rehabilitation,
The right to not be involved in or affected by armed
conflict,
etc....
```

Leased line Internet access

Up to now most of our access has been via dial-up: one modem and phone per user. This does not scale very well, since the number of lines available in a school is necessarily limited. Especially in departmentalized schools, teachers find it difficult to make effective use of a resource that only one or a few students can access at a time. However, many schools are installing local area networks (LANs). Connecting LANs to the Internet makes it possible for many students or teachers to have simultaneous Internet access. Depending on the local phone rates, a leased line may cost as little as four ordinary dial-up lines while offering the possibility of concurrent access by 20+ users. It also makes available graphical interfaces such as Mosaic which require direct network connectivity.

In order to explore the LAN connection, we obtained a supplement to our NSF grant that covers most of the costs for one test site for two years. We selected Franklin County Tech School as the test site because of its strong computer technology program. Also, since all of Franklin County is a single toll free area, a modem pool there provides free Internet access to a large area.

We describe this setup in some technical detail for the benefit of those considering similar connections. A 56 kb synchronous dedicated line connects Tech and UMass. A NAT router ($1600) at Tech controls the feed into this system and a CISCO router ($3350) is utilized at the UMass end. At Tech, a thin ethernet backbone provides connectivity between the Novell 3.11 LAN within the school and the Xyplex terminal server ($2000) which connects the dial-up lines to the NAT router. All dial-up modems are stand-a-lone US Robotics V.32bis modems ($300 each) with their ports locked at 19.2 kb. The Novell network is using "LAN Workplace for DOS" and connects via Novell's Open Datalink Interface (ODI) and is implemented on 486SX machines running Windows 3.1. We estimate that this system can support 20 to 25 simultaneous users without serious performance degradation.

Total startup cost, including installation of the leased and dial-up lines but not labor, was approximately $11,000. Since the 56 kb dedicated line is being used for Internet connectivity, a substantial amount of traffic is for Inter-LATA communications and thus qualifies for the Federal FCC-1 Tariff. This reduced installation costs from $1,000 to $300. A multi-year contract provided a discount on the monthly charges. Leased line charges consist of fixed fees plus a modest mileage component, so that costs rise only gradually with the distance. We pay $1.90 per mile, so the $180 monthly bill for our 12 mile line has a $22.80 mileage component.

Annual costs are about $3000 for the leased line plus dial-ups; estimated repairs and maintenance are $500-1000. The University donates Internet access; if we had to pay the regional Internet provider, that would add approximately $10,000.

Acknowledgment

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Paper (M4-202B)

A Laboratory for Learning and Teaching 3D Geometry

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Key words: 3D geometry, learning environment, mathematics education, simulation, interactive graphics

Abstract

We have developed a software tool named 3D-LAB for learning and teaching three-dimensional geometry. By using 3D-LAB, students and teachers can display a basic three-dimensional solid object (such as a cone, pyramid, cylinder, or polyhedron) in either wire-frame or surface mode, rotate it interactively, modify it, find its segments that intersect with a cutting plane, truncate it by means of a cutting plane, open the basic or truncated solid, draw points or segments in three-dimensional space, and measure lengths, areas, volumes, and angles. The major characteristics of this tool are interactivity of manipulation and variability of the manipulated objects. Two conflicting aims—ease of manipulation and variety of manipulable solids—are realized by a combined method of loading solids first and modifying them next. A three dimensional microworld for learning geometry is realized through the ability to make qualitative and quantitative observations while using 3D-LAB on a personal computer.

Overview

We previously developed two tools in the Mathematics Laboratory Series on personal computers as domestic products of IBM Japan: Calculus Lab (for calculus in high-school mathematics (Akaishi, 1992)) and GeoBlock (for two-dimensional geometry in junior high-school mathematics (Hidaka, 1990; Hidaka, 1992)). Our basic principle was to provide tools for thinking, learning, and teaching, with simple user interfaces. Following the same principle, we have developed another software tool, named 3D-LAB, which allows students to manipulate solids and observe them quantitatively and qualitatively.

By using 3D-LAB, students and teachers can display a basic three-dimensional solid object (such as a cone, pyramid, cylinder, or polyhedron) in either wire-frame or surface mode, rotate it interactively, modify it, find its segments that intersect with a cutting plane, truncate it by means of a cutting plane, open the basic or truncated solid, draw points or segments in three-dimensional space, and measure lengths, areas, volumes, and angles.

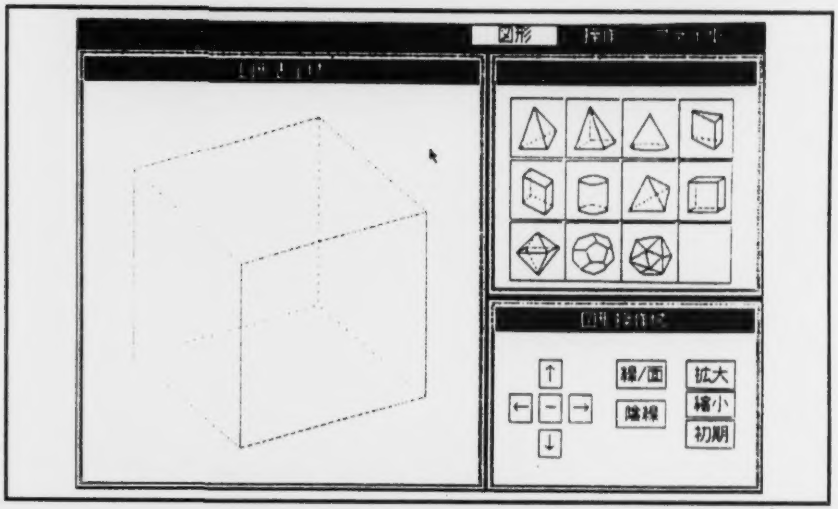


Figure 1. shows the initial display of 3D-LAB. Almost all operations can be performed by selecting from menus, pushing buttons, and dragging points directly with a mouse.

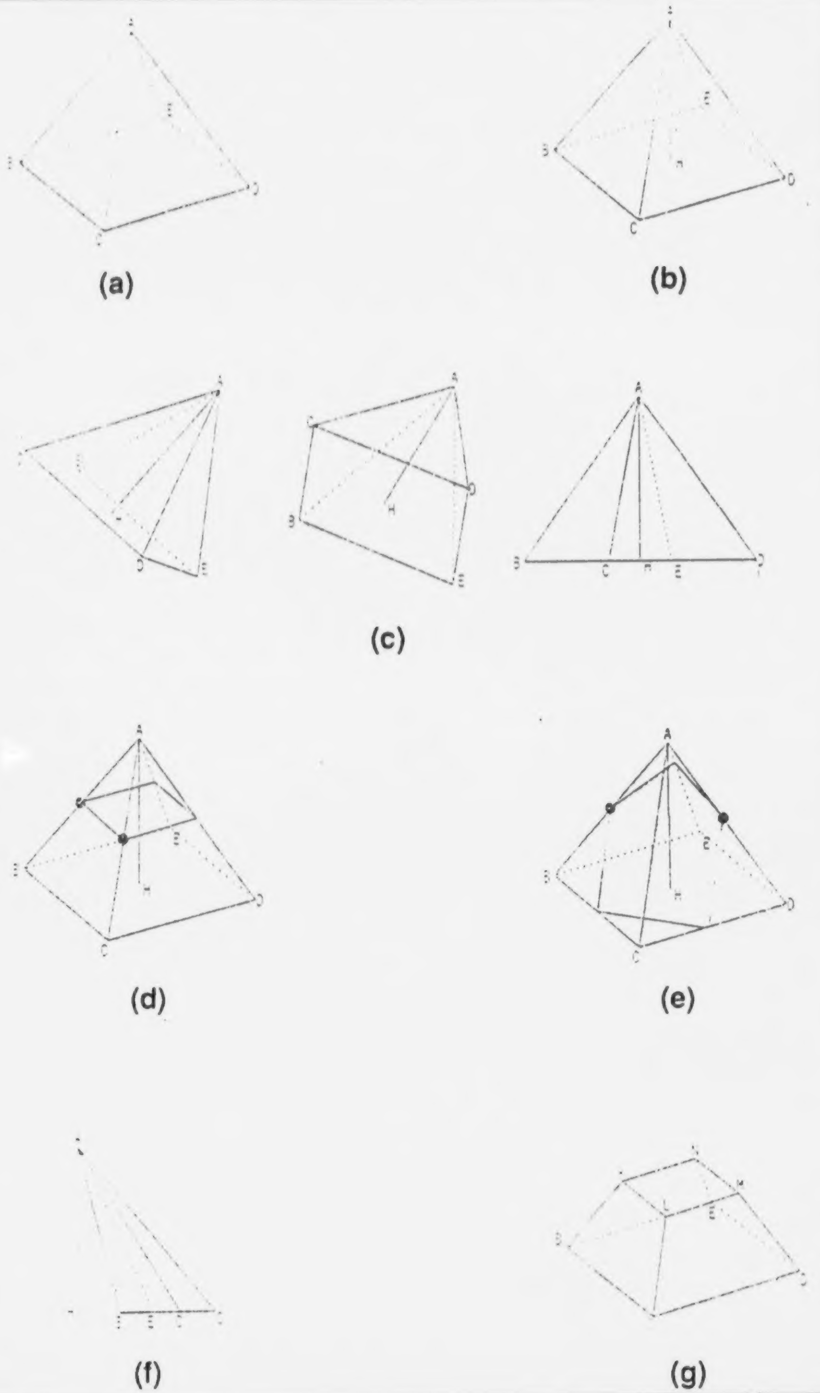
Let us take an example of learning with 3D-LAB. Students can load the pyramid shown in Fig. 2(a) by pushing the pyramid icon. To this "3D-drawings", they can add a segment, the perpendicular line from the top vertex, A, to the base, BCDE (Fig. 2(b)). They can measure the length of AH, the area of BCDE, and the volume of ABCDE, and find experimentally that the volume is one third of the product of AH and BCDE. During this operation, they can rotate the solid, and thus assimilate its three-dimensional structure (Fig. 2(c)).

They can display a cutting plane (Fig. 2(d)) and move it by dragging three control points. The intersecting segments can be calculated and displayed automatically, when the cutting plane is relocated (Fig. 2(e)). Students can also find the area bounded by these intersecting segments, and investigate the relations between the height and volume of the pyramid.

Using modifying functions, they can modify the pyramid so that the top vertex is in a different position, and again measure the height, area, and volume (Fig.2.(f)). This manipulation will help them understand the mathematical principle of the height and volume of a pyramid. Furthermore, they can divide the above pyramid by applying an arbitrary cutting plane repeatedly (Fig. 2(g)), and can open and close the original pyramid or truncated pyramid.

It should be clear now that the major characteristics of this software are interactivity of manipulation and variability of the manipulated objects. In this sense, 3D-LAB is a three-dimensional microworld that allows students to learn the principles of geometry for themselves.

Research was done by Professor Kenjiro Suzuki (University of Tokyo) and Sakiko Wakita (IBM Japan), on how to use the rotating and cutting functions in geometry classrooms. They reported such tool software was effective for improving students' understanding on three-dimensional objects (Suzuki, 1991; Wakita, 19919). We are confident that free manipulation of solids, as described above, will interest students and promote their understanding on 3D geometry.


A
B
C
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E
H
(a)
(b)
(c)
(d)
(e)
(f)
(g)

Figure 2. Manipulating a solid.

Implementations

Generally speaking, it is difficult to define and draw a three-dimensional object on a personal computer's display, even if a three-dimensional CAD system is used. Students and teachers are often novice users of computers, and therefore have special difficulties in manipulating three-dimensional objects. To ensure both ease of manipulation and a variety of solids, we designed this software so that a solid can be defined by (1) loading it, and then (2) modifying or truncating it.

Basic solids

Students start learning by loading solids. 3D-LAB handles 11 basic solids: triangular and square pyramids, cone, cylinder, cuboid, triangular prism, regular tetrahedron, cube, octahedron, dodecahedron, and icosahedron (see Fig. 1). These objects can be displayed in either wire-frame mode or surface mode. The hidden edges are represented by dotted lines, and can be turned on or off. We think that providing functions for changing mode (wire-frame, surface, or hidden-edge on/off) is an efficient way of helping students to understand the meaning of hidden edges, hidden planes, and the depth of three-dimensional space. Users can label vertices with alphabetic characters in order to designate vertices, edges, and faces, and the colors of edges and planes can be changed to highlight specific parts.

Rotating

A solid on the display can be rotated in two directions (vertically and horizontally) by pushing rotation buttons. We designed a rotation matrix for calculating a new two-dimensional image of a solid, so that the rotation operation matches the user's mental model. That is, a solid rotates in three-dimensional space, in the direction indicated by the arrow of the pushed button. It can be rotated at any time while the object is being manipulated. We believe that observation of a solid from an arbitrary direction will familiarize students with the structure of the solid.

Modifying

Pyramids, cones, cuboids, and cylinders can be modified by relocating the position of the top vertex, changing the shape of the base, or changing the height. Modification is executed on two planes: the vertical plane and the horizontal one (Fig. 3). During the modification of the solid, the lengths of edges and the angle values can be displayed. The modifying function enables a user to define solids with various shapes from a single basic solid. It also provides teachers with a simple way of creating teaching materials, including various figures.

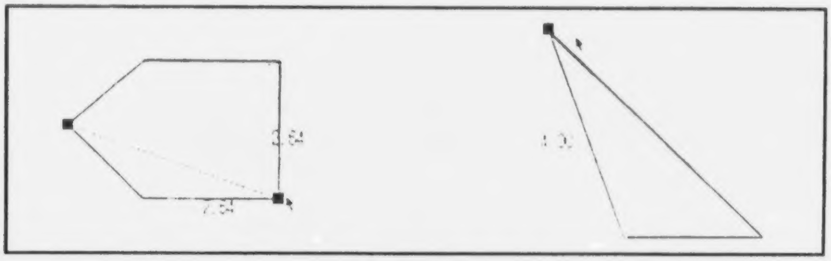

Figure 3. Modifying a solid.

Drawing

Segments and points can be drawn on the edges of the original or truncated solid. In analog mode, points and the starting and ending points of segments are located along all the edges or pre-drawn segments. In digital mode, these points are located only at the dividing points (1/3, 1/4, 1/5) of edges or pre-drawn segments. The digital mode enable a user to draw a specific segment, such as one connecting the midpoints of two opposite edges of a cube. By pushing the perpendicular segment button, students can draw a perpendicular segment from any vertex to (1) an edge or pre-drawn segment, (2) a face, or (3) a cutting plane. Figure 2(b) is constructed by using this function. Students could never draw such complicated figures in three-dimensional space without a computer software tool such as 3D-LAB.

Cutting

A cutting plane is defined by three control points on three edges, and can be modified by (1) changing the locations of these control points, (2) pushing the parallel transformation button, or (3) pushing the rotating transformation button. If the parallel transformation button is pushed, the cutting plane can be moved in the direction normal to this plane. If the rotating transformation button is pushed, the cutting plane can be rotated around the segment connecting two control points. By using these operations, students can interactively observe how the lines of intersection change (Fig. 4). This function gives students a qualitative understanding of solids and cutting planes.

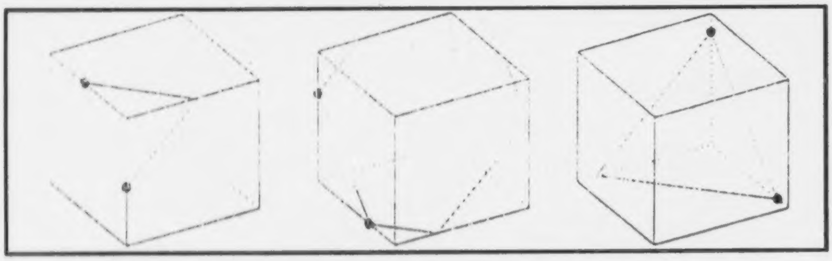

Figure 4. Moving a cutting-plane.

Projecting

There are three projected images corresponding to the xy, yz, zx orthogonal planes (Fig. 5). During projecting, rotation buttons can be used to rotate the object image on each of the three planes. If a user pushes the x-increment button, the image on the yz plane rotates counterclockwise, while if he/she pushes the z-decrement button, the image on the xy-plane rotates clockwise. The original image and the three projected images can be turned on and off on the display. There are two ways of using this manipulation. One is to conjecture each projected image from a solid; the other is to conjecture the original solid from the three projected images. The latter is a more advanced way of conjecturing, and cultivates the students' spatial ability.

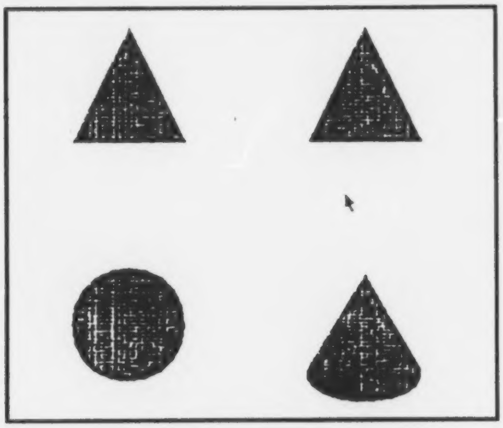

Figure 5. Projecting a cone to three orthogonal planes.

Opening and Closing

There are four types of manipulation in opening and closing a solid. These are opening as specified by the user, automatic opening, closing as specified by the user, and automatic closing. The details of these functions have been described by Y. Hase (Hase, 1993). Figure 6 shows the opening of a cube.

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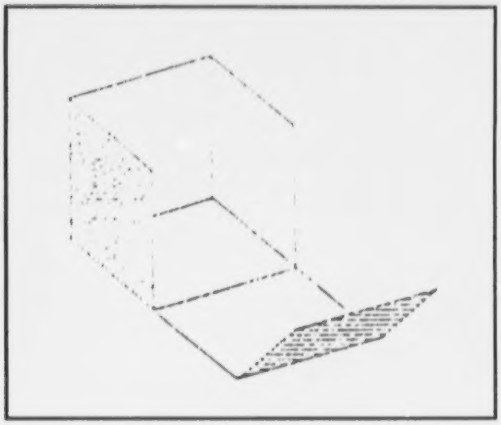

Figure 6. Opening a cube.

Measuring

The user can measure lengths, areas, volumes, and angles in three- dimensional space. Angles are defined by (1) two segments, (2) a segment and a plane, and (3) two planes. On the display, there are two measuring boxes showing measured values, and a calculation box showing the result of calculation based on the two values in the measuring boxes. These three boxes provide a good user interface for quantitative observation of solids.

Conclusions

We developed a three-dimensional "laboratory" named 3D-LAB on a personal computer. In this laboratory, students can manipulate solids interactively and observe them qualitatively and quantitatively. The possible manipulations include rotating, modifying, drawing, truncating, opening and closing, projecting, and measuring. Ease of manipulation is realized by the combination of a mouse and buttons, and by the method of first defining three-dimensional solid objects in the process of loading them, and then modifying them. We believe that there is no similar environment for learning three-dimensional geometry on the basis of experimentation. In the previous research phase, the basic functions of rotating and cutting solids were evaluated in several classrooms by Professor K. Suzuki and S. Wakita. We are planning to evaluate how the complete set of 3D-LAB's functions improves three-dimensional geometry classes.

Acknowledgments

We wish to thank Professor Kenjiro Suzuki (University of Tokyo) and Sakiko Wakita (IBM Japan) for their contributions to the basic research on the usage of rotating and cutting solids in geometry classrooms, and Akio Koide, Yasutomo Nakayama, Yohko Hase, and Takashi Nomoto (IBM Japan), for participating in discussions and for developing the system.

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Project (M4-203A)

Designing Interactive Videodisc Programs to Enhance Teacher Problem Solving Skills

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Key words: videodiscs, training, special education, problem solving, design

Abstract

A series of interactive videodiscs programs are being produced to support the training of special and general educators to serve children with emotional and behavioral disorders. The purpose of these materials is to enhance the problem solving skills of teachers in three areas: (1) understanding behavior disorders in children from multiple perspectives, (2) integrating assessment procedures and service plans, (3) and coordinating instructional and management procedures in the school setting. It is expected that these programs can help bridge the gap between knowledge, skill development, and real-world applications in teacher education.

At the end of this first project year, the computer program and laser videodisc are nearly completed and field testing procedures are being designed utilizing qualitative research methodology for formative evaluation and gathering impact data on problem solving skills for summative evaluation. Field test sites will be linked through telecommunications and implementation ideas shared through E-mail.

The design for these interactive videodisc programs is primarily based on Cognitive Flexibility Theory, one of the constructivist theories which emphasizes the real-world complexity and ill-structuredness of knowledge. It focuses on both the construction of knowledge and the use of that knowledge structure in problem solving. To accomplish this, the materials model the flexibility desired for the learner where information may be learned in a variety of ways based on multiple purposes through multidimensionality and non-linearity.

Many unique and innovative aspects of technology are incorporated in these materials.

- Each interactive program establishes an opening problem solving scenario to anchor the case studies.
- Each program features hypertext case studies of children allowing the user to search for meaningful information through a database of student reports, fact sheets, and other on-line resources.
- Materials placed on the videodisc include video scenes of children functioning in community and school settings, audio interviews with parents and teachers, and audio interviews with national experts in special education.
- Parallel forms of the computer program created with *Authorware Professional* enable the materials to be used in both Macintosh and Windows environments.
- The design allows for flexible use by students as a learning tool or by instructors as a teaching tool.

This presentation will include a description of our overall planning and development process and a demonstration of the program prototype, showcasing these constructivist design features:

- To build on prior knowledge: use of metaphors, real-case scenarios, course prerequisites.
- To support the learner through scaffolding: embedded structure in the program design, help options, hot links between text and on-line resources, and the use of mimetic guides.
- To facilitate the re-organization of knowledge: note-taking options, question generation to prepare for the case conference, presentation of multiple perspectives through the experts, and the option to take different roles and solve different tasks.

Project (M4-204B)

Hypermedia-Based Knowledge Construction and Teacher Education

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Key words: hypermedia, knowledge construction, pre-service teachers, in-service teachers

Abstract

This presentation will center on a five-phase project which has helped inform the types of hypermedia-based knowledge teachers need to know so that they can instruct their students on how to construct their own hypermedia projects. Such information not only helps guide practicing teachers as they acquire the necessary skills and knowledge but also helps the need for developing instructional experiences for pre-service teachers so that they are able to provide the same instruction when they teach.

According to Nelson (1993), hypermedia-based learning environments can be grouped into (a) knowledge presentation, (b) knowledge representation, and (c) knowledge construction. Knowledge presentation refers to students' working with existing hypermedia programs, generally to enhance knowledge. Knowledge presentation refers to hypermedia systems which reflect the storage of information in the human memory system. A form of knowledge construction is when students learn an authoring language and become proficient at using visual and sound digitizing mechanisms (such as scanners and computer-compatible recorders) as well as video and laser discs. With that collection of hypermedia knowledge and skill, students can then produce their own school-sponsored assignments for evaluation. This instructional approach both provides students with an alternative for completing academic tasks and combines production of academic tasks with such general benefits of computer-based learning as motivation, student-determined pace, and one-to-one interaction between student and "teacher." It is this third hypermedia use—knowledge construction—on which our project is based.

This presentation will focus on a five-phase curriculum project. Phase One involved creating a general hypermedia curriculum based on what we felt students would need to be taught in order to develop sufficiently complex hypermedia programs on academic topics. Phase Two was implementing a *HyperCard*-based, month-long unit of instruction, based on Phase One work, which was attended by high school students during the summer between their junior and senior years. Students attended the West Virginia Governor's Honors Academy during the summer of 1991 and selected a strand of instruction called "Hyper-Humanities." This instructional experience had two major focuses: (1) how to research and gather the information they wanted to include in their hypermedia-based projects and (2) the *HyperCard* information needed in order to construct their stacks. They were assigned to work in groups of three or four and to distribute tasks and effort toward completion of their programs among themselves.

HyperCard instruction involved the students' learning the five objects in *HyperCard*: (1) stacks, (2) cards, (3) background/foreground, (4) buttons, and (5) fields. They also learned how to copy and paste line art as well as design their own art via the paint tools. Later in the instruction they were taught how to scan pictures and photos and to incorporate sound via the MacRecorder program.

Phase Three involved "translating" the curriculum into a Linkway-based, year-long unit with high school juniors during the academic year. Phase Four involved the implementation of the year-long, Linkway-based unit which will be completed in

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June, 1994. Included in this phase were additional units on developing interactive video programs. The students were juniors and were enrolled in Advanced Placement English and Advanced Placement Social Studies. The contextual direction of this learning experience was the creation of a fictional town. Each student assumed a role in that town and developed Linkway-based units that reflected the history and literature of the United States from their perspectives as citizens of that town.

Phase Five coincided with the second semester of Phase Four. In Phase Five we have begun to fine-tune what we believe a college-level course for pre-service teachers ought to include so that they can then teach a hypermedia-based language and tools to their future students who can then have hypermedia as an alternative for producing their class assignments. Although some data will be provided during the presentation, the focus will be on the curriculum.

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Revolutionary Classroom (M4-207A)

Revolutionary Classrooms: The Kaleidoscope Classroom

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Abstract

"Revolutionary classroom" means more than using technology to create a revolutionary learning environment in traditional classrooms; it involves creating and renovating traditional classrooms to produce new and innovative learning environments. The physical environment heavily influences the learning environment. This presentation focuses not on how a single instructor has revolutionized a class, but on how a revolutionary classroom has supported different instructional models, united by their use of technology to facilitate significant learning and social interactions in the classroom.

What distinguishes the Kaleidoscope room is its flexibility, chairs and tables that are moved easily into different configurations or stacked out of the way. Thus, while accommodating traditional presentation styles of instructional delivery, the room easily supports much more active and collaborative forms of instruction. Technological support of instruction comes in several forms. Two movable podiums provide the instructor with computers, video tape and laser disc players, pad camera visual presenters, and LCD panel large screen projection onto either of two movable 8' screens. In addition, a student response system provides students with small keypads that connect to the instructor's computer to permit instantaneous feedback and display, if desired, of student responses to questions.

A final feature of this presentation highlights the rather revolutionary administrative support model that provides the technological and pedagogical support in kaleidoscopic and traditional classroom settings. The Consortium for Instructional Innovation employs a collaborative model to harness the fragmented resources of a large university in support of active learning. Assembling machine and human resources from Information Technology, the Library, Media Systems, Faculty Development, Writing Across the Curriculum, and others, the CII has focused expertise and labor into the development of a number of technologically-based learning projects.

Revolutionary Classroom (M4-207B)

Winning the Battle of the Required Statistics Course

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Key words: statistics, visualization, experimentation, labs

Abstract

Dissatisfaction with the introductory statistics course required in many disciplines has spread from the students to the instructors. Some instructors have responded by deleting theory and substituting applications. While realistic applications are vital, proper application of statistical techniques requires the understanding of some basic theoretical concepts.

I believe that student discontent with the theoretical topics is due to the traditional lecture presentation, not the ideas themselves. Visualization software that has been designed to foster student experimentation can replace much of the traditional lecture and convey an intuitive understanding of the theory.

I use the visualization software as a tool to cover theoretical material that might otherwise be deleted. Ideas that are mind-numbing when presented in the usual text or lecture style can become interesting when viewed. I find that my students develop better intuition and greater motivation.

Half of my scheduled class time has been diverted from the lecture hall to the computer lab. During these lab sessions the students use the visualization software on their own, and engage me and their fellow students in discussions about the ideas being presented. I hope to soon replace all scheduled classes with lab sessions.

Special Session (M4-304A)

Train the Trainers: Videodisc Technology Training Materials

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Key words: videodisc, K-12, HyperCard, LinkWay, HyperStudio, multimedia

Abstract

Videodisc technology is becoming increasing popular in K-12 schools. Each Florida school, for example, was provided with one videodisc player several years ago. Like any new technology, however, videodiscs have their own terminology and operating procedures, and, in order to use them effectively in the classroom, educators must be trained in their use and understand the basics of the technology. In this session, presenters will describe and demonstrate inexpensive resources and techniques for staff development which can be used to introduce educators to the basics of videodisc technology.

Developed under a grant from the Florida Department of Education and designed and developed by the staff of the Instructional Technology Resource Center at the University of Central Florida in Orlando, these materials include finished and camera ready copies of instructional materials; transparency masters; sample workshop outlines; suggested activities; "The Videodisc Training Tool," a *HyperCard* (Macintosh), LinkWay (MS-DOS) or *HyperStudio* (Apple IIGS) stack to use in presenting workshops; workshop samples and templates; and "Videodisc Training Wheels," an interactive tutorial program about videodisc technology created in *HyperCard*, Linkway, or *HyperStudio*. Materials are free, and may be reproduced for use in any educational setting.

Project (M4-308C)

Teachers in Technology: A Teacher Sabbatical and Training Project

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Abstract

This session will describe the development of a sabbatical program for teachers that focuses on network technology. Early in the spring of 1993 the University of Rhode Island advertised for teachers interested in spending a sabbatical studying network based technology applications and the connections to classrooms. Twenty-two teachers inquired about this program, eleven were interviewed, offers were made to six teachers and three were able to participate in the program. During 1993-94 teachers moved from a relatively naive view of network technology to become trainers of other teachers using a variety of software and network resources. The presentation describes technical details regarding the development and planning of the program. Each of the teachers will share their reasons for joining the program, their expectations, their experiences and how they expect to use the benefits of this program as they return to their school districts. Teachers have had extensive experience working one-on-one with teachers who are naive network users and will share their views of what has been successful in getting other teachers to become network users. In addition, they will provide insight into the nature of the experiences that they have found most useful in shaping their own views about technology.

Society Session (M4-310A)

Developing Curriculum Standards for Teaching the Social Impact of Computers (ACM SIGCAS)

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Rob Kling, University of California—Irvine
Keith Miller, William and Mary College
Joseph Turner, Clemson University

Key words: ethics, social impact, computer science

Abstract

With the inclusion of the new "tenth strand" on ethics and social impact in the latest curriculum standards in computer science announced in Computing Curricular 1991, there has been much discussion about how to implement this new strand into the curriculum. Both vertical and horizontal integration of this strand has been suggested. The practical considerations of these approaches will be discussed by the panelists from their own experience in developing new curriculum and teaching social impact topics in computer science.

Society Session (M4-311A)

Teachers and Technology: Total Quality Reform (ISTE SIGTE)

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Key words: technology, teacher education, integration, staff development, teacher preparation

Abstract

Building on its work in education and technology, the Office of Technology Assessment is currently conducting an assessment of technology and teachers. The study is focusing on elementary and secondary school educators, analyzing how teachers are trained to use technology, both in pre-service programs and as a part of continuing professional development. Panelists will briefed on preliminary findings from the OTA report to be published in January 1995, and will discuss the implications of these findings for reform efforts in teacher education. In addition, they will be encouraged to contribute "success stories" from their own experiences and will be given ample time to engage panelists in questions and discussion.

Dr. Willis has served as a field-based researcher for the Teachers and Technology study and Ms. Fulton represents the OTA as director for this study. The other panelists have been active in promoting technology use in the teacher education at their respective universities.

This session is sponsored by SIGTE, the Special Interest Group for Teacher Education of the International Society for Technology in Education.

Society Session (M4-312A)

Open Access: A User Information System (CAUSE)

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Key words: information systems, higher education, access services, systems design

Abstract

Boston College has implemented a number of innovative approaches which allow end users, including students, to access personal information and to interact directly with the university's information systems. Mr. Gleason will discuss the design of a systems architecture that facilitates easy access to information and itnegrates these access ervices with other information resouces that are normally found in a campus-wide information system (CWIS).

Project (M4-313A)

ConStatS: Curricular Software for Conceptualizing Introductory Statistics

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Key words: statistics, experimental, question

Abstract

ConStatS is a microcomputer-based program for helping students conceptualize introductory statistics. It is uniquely designed to permit student to select and conduct experiments on statistical ideas. All choices are posed as questions, and for each question a **WHY** and **Help** options are available. These options are designed to permit a wide variety of students to grasp the salience of the question before conducting an experiment. After conducting experiments, students may select from a new set of questions, and pursue their own pathway through the program.

ConStatS is a micro-computer-based "concept piano" for introductory courses in statistics—i.e. it enables students to develop a concrete understanding of the conceptual domain of statistics in much the way a piano is used to gain a concrete understanding of concepts in music theory. The package covers the first seven to nine weeks of almost any introductory statistics course, taught in virtually any department. ConStatS consists of three major parts, each of which contains several distinct programs covering different topic areas:

DATA REPRESENTATION: Displaying Data, Summary Statistics, Transformations, Describing Bivariate Data

PROBABILITY: Probability Measurement and Probability Distributions

BEST COPY AVAILABLE

SAMPLING: Sampling Distributions, Sampling Errors, A Sampling Problem

ConStatS includes carefully chosen data-sets from several different disciplines, including psychology, sociology, economics, biology, and engineering, as well as data of general interest. New data-sets can readily be added by students and teachers. The emphasis of the overall package is on gaining conceptual understanding of statistics. But precisely because statistics is primarily a discipline of application, students gain such understanding best when dealing with real data that they have some prior feel for.

Probably the most distinctive aspect of ConStatS is the rigor with which it pushes students into an actively experimental style of learning. The students are always in control, not just in the sense that they choose what to do next, but in the sense that nothing ever happens on the screen except through choices they make. Each screen presents them with a handful of choices, posed as questions. These choices are just the ones that have to be made to determine some result that will appear next—e.g. the choice of data-range and the number and type of intervals in order to draw a histogram. The only questions that ever appear on the screen are ones that have to be answered to determine a desired result or to initiate a new direction. No "study questions" ever appear, nor do any other didactic elements that would tend to induce students to fall into their customary passive style of learning.

ConStatS embodies the view that micro-computer-based curricular software is truly effective when it functions as a medium unto itself, entirely different from classroom lecture, drill, textbook reading, and educational television. None of these others can be devoted exclusively and uncompromisingly to active experimentation. Carefully designed curricular software can be.

The problem with software designed to force students into active experimentation is that all but a small fraction of students, left to their own devices, will either freeze or become lost when they have to make all the decisions. ConStatS employs a combination of devices to address this problem. First, each program in the package is divided into a large number of "screens", no one of which confronts the student with more than a small number of closely related decisions. The choices the student makes on each screen lead to different pathways through the program, pathways that often loop into one another. These pathways provide an unobtrusive built-in structure that helps guide the student along in an orderly fashion. More guidance is provided at some places by making the decision one between a default value offered by the program and a value of the student's own choosing. Each screen has a one or two sentence "scaffolding" introducing the choices that have to be made, and the student can always back up along a pathway to review or reconsider earlier choices.

Finally, and most important, a WHY and HELP button are always available on every screen, allowing the student who is uncertain or hesitant access to information that will help them over the hurdle. Hitting the WHY button when facing a choice produces a reason why the choice is an appropriate one to be facing. This usually takes the form of a one sentence statement of a typical consideration that someone might focus on when making the choice. For example, hitting WHY when hesitating over the question, "Do you want to change the number of intervals?", produces, "Maybe the histogram will take on a very different appearance with a different number of intervals."—just the sort of thought that a good teacher might whisper in the ear of a student who is hesitating in the middle of an experiment. Hitting the HELP button produces a paragraph or two discussing the choice. This is the only place in the software where book-like elements intrude. But even here the student is actively eliciting the information, looking for specific things that will help them take the next step, in much the way that superior students take a quick look at one or two pages of a book when working something out in a thought experiment.

Project (M4-313B)

Navigating Flexible Curriculum Resources: The Curriculum Map Maker

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Key words: geometry, curriculum, technology

Abstract

Are you tired of cutting and pasting problems and student activities from lots of different books? As part of a curriculum project funded by the National Science Foundation to develop innovative and flexible materials for secondary mathematics focused on geometry, the Connected Geometry project is developing an electronic tool to aid teachers in selecting, adapting, and assembling curriculum materials in flexible ways.

The Curriculum Map-Maker supports teachers in tinkering with their curriculum and in assuming greater autonomy in the design of the materials they use with their students. Building on teachers' current practice of choosing and modifying materials from different sources, this tool enables teachers to conveniently select, adapt, and assemble a variety of activities in coherent and connected sequences. The Curriculum Map-Maker tool supports teachers in reforming curriculum whether they choose to redesign their own curriculum or to more slowly infuse their curriculum with new activities and materials. On the one hand, this means that teachers will readily be able to find a single activity or short sequence of activities to replace part of their current curriculum. On the other hand, the tool will encourage browsing, and it should help teachers identify connections among the activities from our materials library—effectively seeing content not in terms of a single activity or short sequence of activities but as pervasive themes viewed from a variety of perspectives and visited in a variety of contexts.

In this presentation, we will be demonstrating a prototype of the Curriculum Map Maker tool. This prototype consists of some key components:

- Connected Geometry curriculum activities will be indexed in multiple ways. Teachers can find particular materials through a variety of connections—for example, mathematical topic, unifying or organizing theme, habits of mind, geometric content.
- Each activity in the database will contain a brief description which includes information that teachers can use to select materials appropriate for their own classes (e.g., prerequisites, classroom time required, the connections out of the activity). Teachers can browse through the contents of our materials database and read brief descriptions of individual activities.
- The database will include curriculum maps—suggested sequences of activities that we have put together into units—that suggest ways for teachers to use our materials as starting points for developing their own units and courses.

Conference Sessions

Tuesday, June 14, 1994

Session summaries, research papers,

& presenter contact information

Spotlight Session (T1-BRBA)

Virtual Realities: From the Concrete...to the Barely Imaginable...to the Fairly Reprehensible

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Key words: virtual reality, disabilities, writing

Abstract

This presentation deals with deep media, illustrating unusual and offbeat interfaces for future educational computing. The discussion includes attention to new Japanese software initiatives, the development of the smart book, and the elusive RUM, DWIM, and DWIN commands. The presentation provides a broad foundation for considering both the positive and the problematic aspects of investing in certain forms of unreal estate.

Topics include (but are not limited to): The Reality Question, The Addiction Question, The Sex Question, and The Good and Evil Question. The central concept involves "virtual realities," simulations that you seem to enter physically. If text "TELLS and video and film SHOW, then a virtual reality EMBODIES" the world it creates (Randall Walser, Autodesk Research Lab). This leads to considerations of how to represent things that are essentially indiscernible (Warren Robinett, University of North Carolina).

This presentation illustrates virtual reality hardware and software and explores the educational implications of radical shifts in point of view: you can BECOME the data, and you can function in environments in which space itself is the interface. Our involvement with new technologies generally moves from an ambivalent relationship with augmented abilities to the "dawning of irreversible change" (Akram Midani, Carnegie-Mellon University). This presentation suggests some of the implications of virtual realities-for various subject matter areas, in adaptive technology, for understanding autism, and on our expectations and visions for educational computing.

Special Session (T1-BRAA)

Swords Into Plowshares: Dual Use Technologies for Learning

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Panelists:

Ron Fortunato and John Richards (BBN): Applications of the Defense Simulation Internet to Secondary School Education in Department of Defense Schools

Boris Berenfeld (TERC): Applications of Sensors and Instruments from Industry in a Hands-on High School Global Ecology Curriculum

Discussant:

Robert Seidel (Army Research Institute): Prospects for Dual Use Technologies

Key words: industry, government, military, dual use, K-12

Abstract

The end of the Cold War has prompted a renewed effort to find peaceful uses for technologies that have been developed for the military. Both industry and government agencies are seeking educational applications of technologies originally developed for industrial and military purposes. This panel will provide case studies of such "dual use" applications and will discuss issues that arise when attempts are made to transfer know-how and products from military and industry settings to K-12 education.

Special Session (T1-BRCA)

Technology-Rich Mathematics Curriculum for Elementary Grades

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Key words: software, video, integrated, mathematics, elementary, curriculum

Abstract

This session describes the development process and special features of *Math and More*, a mathematics curriculum product in which software and video are central to teaching and learning. Developed as a collaboration between Education Development Center and EduQuest, an IBM Company, *Math and More* is designed for elementary classrooms with at least five networked computers and includes the use of software, video, concrete manipulatives, physical movement, and paper-and-pencil activities. The curriculum focuses on the study of geometry, patterns and relationships, and probability and statistics. It supports the Curriculum and Evaluation Standards of the NCTM by incorporating student-led exploration, cooperative learning, authentic learning tasks, and classroom-based assessment. The original and specialized software tools allow students to construct their knowledge of mathematics through structured tasks, creative challenges, and open-ended exploration.

Society Session (T1-201A)

Teaching Problem Solving to Prepare Students for Computing Courses: A Panel Discussion (CCSC)

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Abstract

While more and more students are arriving in colleges and universities with some computer experience, many are still weak in the problem solving skills needed for the computing sciences, and for success in the first courses in the major. A number of schools, at the secondary as well as college level, have developed introductory courses to help prepare incoming freshmen for a major in computing. This panel will present and discuss several approaches to this course, along with perceived successes and failures.

Special Session (T1-202A)

Logo in Latin America

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Key words: Latin America, Logo, Costa Rica, Venezuela

Abstract

In the early 1980s, educators in various Latin American Countries began using Logo. As in the United States and Canada, a variety of projects started at the grassroots level, driven by the enthusiasm of a few individuals.

Beginning in 1988 with the Programa de Informatica Educativa in Costa Rica a new type of Logo project emerged—large scale and well organized—with a clear vision based on Logo's constructionist philosophy, and providing extensive teacher education and support. Projects of this sort are now underway in Venezuela and are beginning in other Latin American countries.

This panel will give an historical overview of Logo in Latin America with an emphasis on descriptions of current projects and future directions they are likely to take.

Special Session (T1-203A)

Telecommunications and Curriculum

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Frank Odasz, Chair

Panelists:

Sally Laughon, Dan Lake, Stephanie Stevenson, Ferdi Serim, Bruce Daley, Leni Donlan

Michael Waugh, Sandy McCourtney, Mark Nelson, Kay Abernathy, Jim Flanagan

Key words: telecommunications, curriculum, CoSN

Abstract

How does telecommunications enhance K-12 learning? Join the CoSN Curriculum Committee for a report on K-12 telecommunications and curriculum integration and share your own experiences. Help us shape the future of telecommunications in the K-12 community by helping us to discuss guidelines and standards. We will decide together what makes an exemplary project exemplary and what's important about telecommunications in the K-12 curriculum.

The Consortium for School Networking

The Consortium for School Networking (CoSN) is a non-profit, membership organization at the forefront of the effort to facilitate computer-based communication for staff and students in schools across the country. CoSN's mission is to ensure that schools develop sound networking systems and appropriate curricular applications. Computer networking offers students and teachers the potential of equal access to the information available via the Internet. Our goal is for every classroom in the country to have access to these educational resources by the year 2000. Toward that end CoSN brings together the many groups that are involved in K-12 networking.

CoSN Curriculum Committee

CoSN's Curriculum Committee was established in order to determine guidelines for reporting of projects, develop standards of excellence, create an informational database of curricular projects, and disseminate information.

Special Session (T1-204A)

Constructing and Supporting Educational Reform: Presenting the Educational Ideas Followed by an Analysis of Approaches, Problems, Strategies and Solutions to Choosing and Using Conferencing Systems in Support of Constructing Reform

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Key words: Education Development Center, Inc., content knowledge, technology support, implementation, constructivist approaches, resource sharing

Abstract

Education Development Center, Inc. has thirty-five years of experience in educational research, development, leadership and technical assistance for many national reform initiatives on the cutting edge which involve practitioners in learning new content knowledge, pedagogical strategies or systemic approaches. EDC has been at the forefront for combining knowledge of effective professional development with knowledge of technology support. This session will feature presentations from five principal investigators or project directors of five national projects for educational change with a focus on the over-arching educational ideas informing the change. This will be followed by a discussion on the implementation issues and inventions for establishing electronic based constructivist approaches to knowledge building and resource sharing in the service of educational values.

Janet Whitla, President of EDC and PI and Shari Robinson, Development Management for Authentic Teaching and Learning and Assessment for All Students.

ATLAS is a "Break the Mold" Project which represents a partnership among Theodore Sizer and the Coalition of Essential Schools, James Comer and the School Development Program and Howard Gardner and Project Zero and funded by NASDC.

Judy Zorfass, Principal Investigator and Arlene Remz, Projector Director for the National Center to Improve Practice. NCIP represents a collaboration between EDC and WGBH Educational Foundation and is funded by the Office of Special Education Programs (OSEP). It promotes change within local schools and districts so that practitioners will effectively use technology, media and materials to improve educational outcomes of all students with disabilities.

Mark Driscoll, Principal Investigator and Grace Kelemanik, Project Director for the Urban Mathematics Collaborative and the Classroom Assessment in Mathematics Project. UMC is a collaborative of sixteen cities for strengthening mathematics education in inner city high schools, funded by Ford Foundation. CAM is a network for classroom assessment, for developing a growing knowledge base of dynamic history of assessment practice. and funded by the Department of Education through an Eisenhower grant.

Clarice Yentsch, Project Director for technical assistance to the State Systemic Initiative. SSI provides leadership and support to 26 states funded by the National Science Foundation to establish a statewide systemic approaches and partnerships for mathematics and science education.

Daniel Lynn Watt, Principal Investigator, and Nan Youngerman, Teacher Leader from the Madison Metropolitan School District, for the Logo Action Research Collaboratives. LARC, funded by the National Science Foundation to develop and support collaborative approaches for teacher researchers at nine national sites to carry out research about authentic learning and assessment of Logo use in classrooms.

D. Midian Kurland, Senior Scientist and Gunther Anderson, Unix System Administrator conceptualize and adapt technology to support the missions and long term and emerging for educational change projects.

Molly Lynn Watt, Senior Associate and Director of the Action Research Center at EDC, Inc. will serve as chairperson to this session.

The audience is invited to serve as discussant to ideas and issues presented in this session.

Revolutionary Classroom (T1-207A)

Composition with a Twist of Technology: Logo, Music and Writing

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Key words: Logo, math, music, integrated curriculum, writing process

Abstract

It all started two years ago when the lower school computer lab found its new home next door to the music room. Close proximity and curiosity about each other's programs led to the realization that two people from seemingly disparate fields had much pedagogy in common-constructivist environment, integrated approach, authentic assessment. Enter a third person, fifth grade teacher and language arts specialist, who joined the fun. Our next step in the brainstorming process was to examine our knowledge of our own disciplines and articulate what was important to us within our own frameworks. Once again, there were significant commonalities. We each sought to create learning experiences that demanded a higher level of abstract thinking which would result in the construction of new cognitive meanings.

The product of this initial collaboration was a curriculum in which the learner is required to build on previous knowledge, find patterns, transfer ideas into other arenas and use varied communicative tools to express ideas. Logo not only creates the environment that allows this type of learning to happen, it is embedded in the process of constructing meaning. Our goal is to encourage people to consider this powerful use of technology in creating their own curricula. Our collaboration is on-going and in retrospect, we've come to the realization that the process we go through in creating curricula parallels the learning experience of our students.

This presentation will engage the participants in demonstrations of our integrated curricula which have been successfully implemented with elementary students. This demonstration will include components of music composition, Logo programming, mathematics, and the writing process.

Revolutionary Classroom (T1-207B)

Challenge to Change: Restructuring Through Project-Based Learning

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Key words: project, community, collaborative, technology

Abstract

The West Tisbury and Oak Bluffs Schools are located on the Island of Martha's Vineyard, Massachusetts. During the past two years these two schools have been involved in a project-based learning initiative titled "Challenge to Change," funded by the National Foundation for the Improvement of Education and the State of Massachusetts. The major strands of the Challenge to Change project are:

- students setting the parameters of their own learning using an exploratory inquiry, critical thinking, and problem solving approach
- students developing specific skills in conflict resolution and decision making
- students working in learning teams which are balanced for maximum potential, address the full range of "intelligences," and allow students to work to their strengths
- students tackling real, complex problems in the context of the broader community with a focus on interdependent learning and genuine understanding
- students' use of sophisticated portable technology as tools for their research

A synopsis of the project

An electronic representation of a multi-age hands-on community project. Teams of students discover, investigate, and document findings on topics which are personally important to them. They share their own resources and then draw upon the wealth of people in the community (e.g. research scientists, writers, inventors, historians, media experts) to assist in and extend their learning. The students use primary resource material, the site and/or person that is the foundation of their research, to enhance their experience within a subject. Working collaboratively, the teams use state-of-the-art portable technology for project based learning. Their electronic toolbox includes portable computers, integrated bulletin board and database software, multi-media authoring, video taping and editing, scanning and digitizing of images, and networkable collaborative writing and drawing tools. They create a museum exhibit to present their findings using the same technological tools they use for their research. The students are the curators of their own presentations, contributing to the content of the Vineyard Museum, the local history center of the island. Their textual, video, audio, and graphic information is accessible to the community and through their networks, to the world, opening the doors to a dynamic flow of cultural understanding. Working with their interests and strengths, students reach out from their classrooms in this example from an initiative called Challenge to Change.

Revolutionary Classrooms (T1-207C)

Classrooms Without Walls: Teaching in Technology-Rich Environments

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Key words: information, interdisciplinary, multimedia, technology, telecommunications

Abstract

In technology-rich classrooms students are involved in real world, interdisciplinary projects which focus on current issues affecting the global community. With all projects, students communicate electronically with peers and experts, work on various software packages to enhance their basic skills, participate in a web of interrelated activities, and culminate with a published document using desktop publishing, or a multimedia presentation incorporating text, graphics, audio and full motion video.

In order to successfully implement these types of technology the teacher must assume a new role. A blending of cooperative learning, small group instruction, peer tutoring and whole class discussion is essential in creating an active learning environment.

Technology holds the key for school restructuing. Through this means, we can teach our students to organize, analyze, and evaluate the increasing amouns of information available to them, while preparing them for the technological work force which they will be entering. Additionally, through the the use of telecommunications, the student's concept of "classrooms without walls" will become a reality as they learn about and communicate with people across the globe.

In today's hi-tech society, a place where traveling across the globe takes hours instead of weeks, and communication across regions takes the form of real-time audio and video transmission instead of a written letter, students are increasingly coming in contact with vast amounts of information and a myriad of cultures. As a result, students must be taught, not how to locate information, as in the past, but rather how to manage the constant barrage of data. Analyzing, synthesizing, and organizing information become the important skills for teachers to develop with students.

Teaching through real-world, interdisciplinary projects which focus on current issues effecting the global community provide students with opportunities to develop higher level thinking skills. These projects include many different types of activities and learning objectives and successfully integrate technology into the curriculum. Basic skills are taught to students through a variety of software programs. Internet is used by students to discuss issues with other students throughout the world, and to access great amounts of information on the topic they are studying. Databases, spreadsheets and other computer applications are used to help students organinze and analyze the information. The projects are culminated with a published document using desktop publishing, or a multimedia presentation incorporating text, graphics, audio and full motion video.

The major components for successful implementation of such student–directed interdisciplinary projects include access to technology, teacher training, and classroom management. Students must have access to the technology, including computers, multimedia hardware, and Internet, right from their classroom. Teachers must be comfortable using all of the software as well as the multimedia and telecommunications hardware. Finally, and probably most importantly, teachers must orchestrate the classroom in order to create an appropriate learning environment. A successful blend of cooperative learning, small group instruction, peer tutoring and large group discussions are necessary in order to keep all students actively involved. The students learning evironment is no longer restricted to their physical environment, (their classroom and school library) it encompasses the world. Students have access to libraries, databases, universities, museums, specialists, and peers from across the globe. For example, when studying water conservation students identify local issues, discuss journal articles, take part in on–line discussions with experts, compare concerns with peers throughout the world, collect, organize and analyze data through the use of a database, and present comparisons, conclusions, and possible solutions to today's water concerns in a multimedia presentation. This real–life issue is used as the basis of a project teaching basic skills and higher level thinking skills across all of the curriculum areas.

The common thread throughout all of these activities is that the teacher acts, not as the dispenser of information, but as a facilitator in the process of locating and then analyzing and presenting information. These skills are not just desirable, they will be absolutely necessary for students to master as they enter the "information age" of the twenty-first century. Restructuring the classroom in this manner brings with it the sense of excitement, discovery, and relevance that technology inspires and our students demand.

Revolutionary Classroom (T1-208A)

Telecommunications: "Linking Classrooms with Prisons—A Look at Alternatives"

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Key words: telecommunications, at-risk students

Abstract

Telecommunication is the revolutionary force in this classroom. This project, the first of its kind, links classrooms of students from around the world, to a maximum security prison in West Virginia, via computer modem. Students from classrooms in distant locations explored the societal forces at work, which resulted in individuals paying the ultimate price of years in prison, some for the rest of their lives. Throughout the fifteen-week project, students at Moundsville Junior High School in Moundsville, West Virginia served as the focal point for this unique project. Using E-mail, students forwarded inmate responses to classrooms around the world via the AT&T Learning Network. Students in distant locations asked personal questions to an assigned inmates who remained anonymous as did the students. Although targeted for the at-risk student population, all students dramatically benefitted from the electronic exchanges with the inmates. Inmates shared candid and personal experiences in helping all students consider consequences of and alternatives to crime. Telecommunication technology allowed for anonymous yet close personal contact between students and inmates. This electronic bridge served to overcome not only distances and prison walls, but moral, social, and family issues as well as stereotypes. This presentation looks at the benefits of the fifteen-week project for both students and inmates. Handouts of actual student/inmate dialogues will be available at the presentation.

William Burrall is the 1993 National Technology Teacher of the Year selected by *Technology & Learning* Magazine and IBM Eduquest.

Revolutionary Classroom (T1-208B)

Business Partnerships + Technology + Real World Applications = Revolutionary Classrooms

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Key words: multimedia production, multicultural exploration, computer animation, business partners, real world, collaboration

Abstract

You know something is going right when the thirteen year old student solving a computer problem over the phone with a technical support person from a major computer company is offered a job. Our response to the technical support person was "Sorry, he needs to graduate from high school first!" (Or does he?)

Business and educational partnerships can enhance both the business and the school environments through collaboration. These partnerships have helped the students and teachers at Edgewater High School make quantum leaps in using specialized technologies prevalent in today's work place.

The Multimedia and computer animation students work closely with IMAGICOM, a multimedia production and design company in Central Florida. Bob Konikow, company president, provides his professional expertise pertaining to the feasibility of individual project development with other community and business partners. This collaboration and course curriculum was started with the help of an Apple Computer, Inc. Crossroads II Grant from the Community Affairs Department. Each project is worked on by a team of students, a teacher and business partners. The business partner is requested to meet with the students and conduct "business" in the same manner as they would with other groups they purchase contracted services from. The teacher oversees the project and provides guidance, help with group dynamics, time management, technical assistance and access to other resources that help to get the job done. The student groups range in size from three to eight depending on the type of project, interests, student skill levels, maturity and experience. Projects under development at this writing include:

- Florida Birds of Prey CD-ROM and laser disk in collaboration with the Florida Audubon Society and the Orange County Public School District.
- Snakes CD-ROM in collaboration with the Central Florida Herpetology Society.
- The History of Firefighting Kiosk in collaboration with the Orange County Historical Society.
- Computer Animations for 6Extreme. This program is geared toward the nine to fifteen year old audience and is a locally produced by the CBS affiliate, WCPX.
- Animated logos, program segment transitions, and commercials for a variety of local business partners and community groups are developed upon request.

A variety of students work with the Technology Coordinator as Techies. These students work on a variety of projects pertaining to the maintenance, installation, and operation of computers, networking, telecommunications and training. They also:

- Provide internet other telecommunications training for teachers.
- Install, replace and troubleshoot equipment and software malfunctions.
- Evaluate, recommend and negotiate equipment and software purchases.

Additionally Novell systems administrator certification training is an option for students assigned to the Technology Coordinator.

Students enrolled in the Bio-engineering classes provide a service to the community through the Water Sentry program. The students and teacher work in conjunction with the City of Orlando Storm Water Utilities Department and the Orange County Environmental Regulation Department. The students routinely monitor the water quality in a chain of lakes. Students earning dual enrollment high school and college credit in Engineering Systems modeling, take the data collected by the Water Sentry team and create "what if" scenarios about the lake environment to help predict future trends.

The Trainable Mentally Handicapped and Language Learning Disabled students are trained and spend part of their school day working at Radisson Hotel and the local K-Mart store.

The overall focus of all these projects is to give the students life long employability skills that the collaboration with the businesses offer. The students don't have to wait until they graduate from high school to gain this valuable experience and learn how to interact in the workplace.

Projects like those previously mentioned are all realities and similar programs can be developed at any school.

Revolutionary Classroom (T1-208C)

National Geographic Kids Network: Telecommunication Programs Meaningfully Integrate the Curriculum

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Key words: telecommunications, Kids Network, *National Geographic*, integrated curriculum

Abstract

National Geographic **Kids Network** telecommunication units such as **Acid Rain** have been an essential and exciting part of my elementary multi-age program for five years. In these units children integrate skills they have learned in many areas of the curriculum. They do not learn skills in isolation, but discover the *need* for knowing certain skills in order to investigate the problems they are studying.

Children connect math skills with "real world" problem solving as they gather real data, graph, and interpret it. They telecompute with their research teammates. They realize how they must write clearly so that others will understand what they have written. In the science strand the children practice the scientific method as they experiment, record information, and share their results. Children learn computer skills such as telecommunication, word processing, and how to create graphs and maps on the computer. They find that the computer is a tool, not a "glorified" workbook. In each of the units children research and write about their communities—uncovering the history of their towns as related to the problems they are solving. Children learn how to use latitude and longitude to locate their teammates, how to relate topography to the problem being studied, and how to create maps.

The children reach from my classroom to classes all over the world. *National Geographic*'s **Kids Network** projects have revolutionized learning and teaching in my class.

Revolution in my Classroom

As I remember my elementary classroom in the fifties, I recall learning isolated subjects while seated in rows. If there was enough time at the end of the day we were asked to open our drab geography books. We took turns reading orally, standing up straight, while the others sat with their books propped up on the desks in front of them. It should have been so exciting to learn about far away places and people who were so different from us. But it wasn't. I promised myself that when I became a teacher, I would search for exciting ways to help my students learn.

Five years ago I found *National Geographic* **Kids Network** telecommunication units. I have worked in four of the units: **Hello**, **Acid Rain**, **Weather in Action**, and **What's in the Water**. In these projects children apply skills that they have learned across the curriculum (social studies, writing, mathematics, science, and computer skills) so that they might study and help correct an environmental problem. **Acid Rain** is one of my favorite units.

Acid Rain

In the **Acid Rain** project children work in teams to build rain catchers, collect the rain or snow, learn about pH, measure the acidity of the community's precipitation, write a community description which reveals information about power plants and automobile usage, and telecompute their results internationally. Even though there are about five hundred classes participating in each unit, each class is assigned to a research team comprised of classes from twelve schools. Each study group in my classroom becomes experts on the information that one class in our research team has gathered and telecomputed to us.

At the end of the six week unit, the children receive data from all of the world. They see which areas have the most acid rain and try to understand why. Lively discussions take place throughout the unit. Children talk about what they can do to help decrease and prevent acid rain. They communicate with power companies and with the teams on the **Kids Network**. Children investigate a real problem and learn how they can become part of the solution.

Integrated Learning

While participating in **Kids Network** units, children discover the *need* for learning how to graph, how to collect meaningful data, and how to communicate this information. They do not learn skills in isolation, but discover the *need* for knowing certain skills in order to investigate the problems they are studying.

Many subject areas are drawn into each unit. In math the children solve problems using real data they have gathered. They read, interpret, and create graphs of their data and their research teams' information. They work with positive and negative numbers. Children connect math skills with "real world" problem solving.

They write to their research teammates and receive letters from them. They realize how they must write clearly so that others can understand their telecommunications.

In the science strand the children practice the scientific method as they experiment, record their information, and share their results. Children learn computer skills such as telecommunication, word processing, and how to create graphs and maps on the computer. They also see how computers are used as *tools*, not just for games and "drill and practice exercises".

In each of the units children research and write about their communities—discovering the history of their towns as related to the problems they are solving. The study of geography included in these units helps children learn how to use latitude and longitude to locate their teammates, how to relate topography to the problem being studied, and how to create maps.

It is so amazing to see children reach out from our class to classes all over the world to study a problem and then contribute their ideas to the resolution of the problem. How revolutionary!

Society Session (T1-304A)

The Educational Impact of Scientific Visualization (ACM SIGCUE)

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Key words: science education, computer graphics, visualization, simulation, collaboration

Abstract

The purpose of computing, and science, and science education, is insight not numbers. Since the NSF panel and report on "Visualization in Scientific Computing" in 1987, the movement to develop visualization techniques and use them effectively has radically changed the way a great many scientists "do science." And now it is beginning to transform the way we teach science.

The term "Scientific Visualization" is used to refer to the process of learning about scientific/engineering phenomena by observing and interacting with computer-generated images that are graphical models of these phenomena. Ideally, it requires a "virtual world" for creating models to be rendered into visual forms and manipulated to discover hidden relationships among the visualized data. Actual data is used to initialize computer simulations containing models of the scientific phenomena being studied. The output produced is then "visualized"; that is, computer graphic techniques are used to produce images that can be manipulated by the viewer to reveal patterns that are almost impossible to detect in the masses of numeric data.

Scientists have found that Scientific Visualization is extremely effective not only as a tool for discovery and learning but also as a tool for communication and teaching. And early trials with science classes at all levels are showing its potential to revolutionize science education.

This session will report on the current use and potential of Scientific Visualization to enhance learning in science, particularly at the pre-college and undergraduate levels. The foundations of the method and the history of its application to science education will be discussed and ways to use scientific visualization to enhance learning in science will be illustrated with appropriate videos. Science teachers will tell about and show videos of their classroom experiences using computer-supported visual techniques to help their students gain a deeper understanding of concepts and equations as well as to participate in the processes of scientific work.

The session will conclude with a status report of the current state of the technology and its availability (with a resource list as handout) and some predictions of future directions. Questions will be encouraged throughout and time will be allowed at the end for further discussion and questions.

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Distance Learning (T1-306A)

Declaration of Interdependence: Technology and Mathematics/Science Education Systemic Reform

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Key words: National Science Foundation, SSINet, distance education, online teacher communities, video meetings, mathematics, science

Abstract

The National Science Foundation is funding a $300 million effort called the State Systemic Initiative. There are currently 26 state projects, funded for five-year efforts to improve mathematics and science education, and the use of technology across their states. Various technologies are being used in many effective ways in these efforts.

Examples to be used will illustrate ways in which technology is being employed to help realize and sustain efforts that are systemic in nature.

- **SSINet** was created and is being used to connect the states and various stakeholders on the projects. Samples of kinds of communications, and the ways in which SSINet assists project players will be illustrated. These include effective Internet training, in house communication, job alikes etc. Examples from online communications. (*Project technical assistance efforts, housed in Massachusetts.*)
- **Distance education** efforts for curriculum updates, in service courses. Video clips from Math Vantage, a middle school effort, and NIH/EPA funded TV curriculum efforts on Radon and the Wetlands. (*Nebraska*)
- **Broadcast, simulcast/satellite interactive town meetings** for public awareness efforts. Video clips from broadcast with the Governor, teachers from 10 sites, and Secretary of Education Riley. (*Louisiana*)
- **Online teacher communities** for professional growth in rural areas. Examples from online communications. (*South Dakota*)

Throughout the session, we will be dialoguing with the participants about ways of using technology to facilitate excellent mathematics and science instruction, ways in which participants can leverage resources (including human resources), and ways to sustain efforts.

Project (T1-308A)

Teacher Training Interactive: An Update

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Key words: staff development, multimedia, HyperCard

Abstract

The Teacher Training Interactive project was started at College Misericordia in the 1992-93 school year in response to school reforms and the need for staff development in the area of educational technology. The primary school reform that triggered the conceptualization of the project was **inclusion** and the associated need for 'regular' education teachers to deal with the resulting diversity of student abilities and needs. In addition, the framework of the project acknowledges the value of educational technology in addressing the diverse needs of students, and therefore, the need to train teachers in the effective use and integration of technology.

The word "interactive" in the title of the project actually indicates three areas of interaction that are contained in the project's design. Teachers from neighboring school districts, who participate in the inclusionary process are released by their school districts over the period of a semester to work closely with faculty at the College. Their primary role at the College is to aid college faculty in the delivery of methods courses. This interactive relationship lends a sense of realism to methods discussions and also helps classroom teachers update their knowledge base regarding current trends in education.

The second area of interaction is between classroom teachers and college faculty and graduate assistants who work in the College's Educational Technology program. Classroom teachers are introduced to a wide array of multimedia based hardware and software including *HyperCard*. In addition, they are trained in the integration of the technology across the curriculum. As their contribution to the project, classroom teachers design and add a *HyperCard* component to the Teacher Training Interactive program, an interactive multimedia database of research based teaching and learning strategies.

The final area of interaction is between classroom teachers and their peers. Skill development must transcend the small numbers of teachers who are able to directly participate in the project. For that reason, teachers are expected to use their knowledge to influence their peers in the use and integration of technology, and also share their information regarding current trends in education.

Although the project has been limited to only a few participants due to limited funding, a great deal of success has been observed. Teachers who have participated in the program have become institutional leaders in planning for the integration of technology in their respective districts. Their work with methods classes has precipitated a distance learning link in which college students are connected to elementary students. Finally, participants have made significant contributions to the multimedia database for staff development. The ultimate goal of the project is to create a seamless environment in which the interactions fostered by the project become automatized.

Project (T1-308B)

An Approach to Technology Integration for Teacher Education Faculty

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Key words: technology, integration, teacher education

Abstract

A desirable goal for many teacher education programs is for technology to become an integral part of the teaching and learning environment for faculty and students. Technology must be introduced to faculty members in such a way that they see a purpose and a use for technology in their courses. This project describes a mentoring approach that was used to assist reading and language arts faculty members who were interested in using technology in their courses.

A mentoring program was established that teamed an instructional technology faculty member with faculty who were interested in integrating technology into their content courses. This group met weekly to discuss curriculum issues and to learn how to use various pieces of hardware and software. Instructional emphasis was placed on integrating technology as a means of delivering the reading and language arts curriculum. The mentoring group maintained a focus on using technology which pre-service teachers could use for multiple purposes during and beyond their pre-service teacher preparation as well as in the classroom with children.

Project (T1-308C)

W.T.E.G.: A Project to Integrate Technology into Pre-service Teacher Education

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Key words: pre-service, teacher education, teacher educators, curriculum integration

Abstract

As part of a four–year effort to improve teacher preparation programs in Westchester Co., NY, the Westchester Education Coalition has been spearheading a project with teacher education faculty in 9 local colleges and universities and with select classroom teachers. The project, known as the "Westchester Teacher Education Group," or "WTEG," is aimed at giving new skills, knowledge, and understandings to teacher education faculty in four focus areas: technology, multicultural diversity, math/science, and work–based learning. This presentation will highlight two years of activities and products of the

"WTEG Technology Task Force" and the Concerns–Based Adoption Model (CBAM) used to support its work. Over a 2–year period, the task force met at least once a month to receive training in DOS, file management, word processing, spreadsheets, multimedia, use of databases, e–mail, and telecommunications.

A support, hotline telephone number was also provided, as were Saturday reinforcement sessions, numerous written materials, journal subscriptions, and technology conference information. Data was taken after each meeting, participants were interviewed regularly, and communication between task force members and project coordinators kept a "pulse" on participants' needs, frustrations, and accomplishments. Facilitators and coordinators made adjustments accordingly. Sharing sessions were scheduled regularly to enable participants to learn/commiserate with one another. These sessions also provided project consultants a chance to offer assistance from 2 different vantage points: technical and curricular. WTEG participants were frequently encouraged to try an alternative or get more training on a particular area whenever necessary. Integration proceeded at various rates and various depths, depending on the individual's readiness level.

Within 15 years, all 15 college faculty and 9 nine classroom teachers were comfortably using technology in connection with their teaching. While the levels of use varied widely depending on the content of courses, the teaching or administrative duties involved, and the individual's entry level skills and knowledge into the project, every participant advanced beyond a minimal understanding. All participants showed positive attitudes toward technology.

A WTEG publication of revised course syllabi representing various content areas of the 9 teacher preparation programs will be available for dissemination in 1994.

Special Session (T1-310A)

Empowering Young Children With Hypermedia

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Key words: hypermedia, creative environments, early childhood education, special needs, interdisciplinary projects

This set of project presentations focuses on the use of hypermedia to help students develop basic skills in creative environments. The presentations will use video tapes of classroom activities and exmaples of hypermedia materials to show what can be accomplished through the creative application of hypermedia and to enable teachers to take steps toward employing similar strategies in their own educational settings. There will be three presentations:

1. *Revolutionize Learning with Hypermedia* by Peggy Buffinton, Rick Swartz, and Edward Vockell, will describe the use of multimedia materials to enable fourth graders to conduct their own research and to present their ideas to their peers and to others through computerized presentations.
2. *Computer Intervention Strategies for Young Children with Disabilities* by Tony Latess, will demonstrate the use of multimedia authoring software to develop interactive applications for prekindergarten children with a variety of disabilities. Each application covers an area for which little commerical software is available and is tailored to help individual children reach unique IEP goals.
3. *The Buddy System Project: Extending the Foutrth-Grade Day with Hypermedia* by Helen Jancich will describe how 400 fourth-graders use computers, modems, and printers provided by the Indiana Buddy System Project and installed in their homes to develop interdisciplinary hypermedia projects. Students share ideas with teachers, parents, and peers in school and at home to develop social studies, science, and communications skills.

Special Session (T1-312A)

Constructionist Images of Programming

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Key words: programming, constructionism, learning, Logo, games, robotics

Abstract

In this panel, we propose to re-examine the role of computer programming in schools and in learners' development. We present our vision of programming which is based on constructionism (e.g., Papert, 1980, 1991, 1993). Constructionism emphasizes that learning takes place best when the learner is engaged in building something external and shareable—be it a book, a sand castle, a robot, a simulation, a game, or a simple computer program. The following four approaches will be described: software development paradigm (Harel, 1991), game design (Kafai, 1994), robotics design (Martin, 1992), and multi-processing programming paradigm (Resnick, 1992). We present and discuss several examples of what students (and teachers) can do with computers in schools, and how programming activities can contribute in particular ways to their learning, teaching, and thinking about their own thinking as well as about the world around them. In our vision, technological knowledge such as programming is seen as reflective and valuable not only in its own right but also capable of enhancing the learning of many other things.

Introduction

For the past 20 years the questions "Is programming good for children?" and "What role programming should play in schools?" have been asked repeatedly. Recently, many people have even wondered whether programming will become obselete with the advent of new applications and new multimedia tools. In this panel, we re-examine the role of computer programming in schools and in learners' development. We will describe our vision of programming which is based on constructionism (e.g., Papert, 1980, 1991, 1993). Constructionism emphasizes that learning takes place best when the learner is engaged in building something external and shareable—be it a book, a sand castle, a robot, a simulation, a game, or a simple computer program. We present four (complementary) images of programming:

Software Development Paradigm

Many of the limitations of traditional programming courses are related to the facts that students do not program intensively, programming is not used in various and meaningful contexts, and programming is not integrated with the learning of other subject matters. Doing programming within the "Software Development Paradigm" provides opportunities to recast dramatically children's learning and thinking in the school context (Harel, 1990; Harel & Papert, 1991). By taking the roles of software designers—and by programming interactive pieces of software for the use by others—students develop knowledge and understandings in ways not fully possible by other teaching methods. Programming is seen as a tool for *knowledge reformulation* (e.g., of fractions and Logo) to support and extend the learning of, for example, mathematics, geometry, reading and writing, and interface design. The "Instructional Software Design Projects" series in which children created software to teach fractions to younger students will be used as an example.

Game Design and Programming

Learning programming through software development provides one example of how different subject matters can be integrated in a powerful and meaningful way. Programming video games provides an extension of this paradigm (Kafai, 1994). In the context of designing and implementing video games, programming can also become a medium for *personal and creative expression*. Children can engage in various subject matters such as mathematics and science; in addition, they can construct fantasies and build relationships with other pockets of reality that go beyond traditional school approaches. The aspect of fantasy is rarely promoted in programming and the learning of science or mathematics. The "Game Design Projects" series in which children designed their own video games to teach either mathematical or scientific concepts to younger students will provide examples of actual classroom implementations.

Robotics Design and Programming

In our work with MIT students engaged in designing robots for competitive performance events, we see conceptual and practical challenges in programming these robots to successfully perform complex tasks (Martin 1992). Many mobile robot researchers are developing alternate control methods for specifying the behavior of robotic systems, but few have looked at how a wide spectrum of novice engineering students approach the same problem. In mobile robotics, certain assumptions that engineers are used to making about systems don't hold. For example, sensors regularly produce erratic data, and actuators don't necessary achieve the desired effect. Engineering students, especially those that may be experienced programmers, often fail to recognize these realities, and develop control systems that are fragile rather than robust. In mobile robotics programming, not only do conventional methods fail, but alternative, "bottom-up" styles of design are often more effective—challenging the educational imperatives of the modern engineering university.

Multi-Processing Programming Paradigm

The educational possibilities for programming have been limited, in part, by the nature of programming languages themselves. New programming paradigms (such as object orientation and multiprocessing) can deeply affect how and what children program, and what they learn in doing so (Resnick, 1990, 1992). First, new paradigms can strikingly change what types of projects are possible (and natural) for a student to undertake, greatly expanding the student's design possibilities. For example, controlling the actions of multiple characters in a video game, or multiple machines in a LEGO/Logo project, becomes much easier and more natural in a multiprocessing programming environment. Second, new programming paradigms can support and encourage new ways of thinking about phenomena in the world. For example, when students see patterns in the world (say, a flock of birds), they typically assume some type of centralized control (a leader of the flock). But after programming in a multiprocessing environment, students are likely to move beyond this "centralized mindset," recognizing that patterns can arise through decentralized interactions.

These images of programming emphasize many common features, among them: 1) the integration of programming with several other activities, 2) the design and production of full-fledged and complex computational products, 3) the use of programming for presentation of ways to think about and understand the world, and 4) all these approaches to programming also make technological knowledge accessible to populations which have traditionally disenfranchised with technology. Our research projects tell us that these activities involving computer programming can offer learning experiences and multiple insights about the world—in forms, contents, actions and processes not available or possible by other applications and tools.

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Project (T1-313A)

Overcoming Impediments to Integrating Technology into Education Courses: A Project Report

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Key words: technology, teacher education, integration, educational change

Abstract

This project presentation will report on efforts to integrate computer-based technology throughout our teacher education program. The project has been supported by a Teacher Preparation Grant from the IBM Corporation with additional resources provided by college and university funds. The model for change that we have adopted is based on research on successful implementation of innovations in education including the need for some faculty, led by the college's technology coordinator, to act in various change agent roles. An implicit assumption of this model is that our long range goal of integration of technology involves a substantial change in practice for many faculty members and will therefore be difficult to attain. Our approach has been to begin with faculty members who are open to increased use of technology, support their efforts, work to establish a critical mass of involved faculty, and eventually institutionalize curricular changes.

As with most colleges of education, funds for technology have not been plentiful, but hardware and software resources have steadily grown in the past few years. As a result, two instructional computer labs have become available for "non-computer" classes to use. While a number of professors have reserved the labs for one or two class periods to demonstrate computer applications in their field, two faculty members opted to teach their entire non-technology courses in a lab for the first time during the 1990-91 academic year. (Since then, the number of faculty choosing to use the labs has been steadily growing—numerous faculty have taught class sessions in the labs and four additional professors have scheduled their methods classes to be held exclusively in lab facilities.) As might be expected, though, their experiences were not without many of the obstacles that tend to accompany efforts to teach with technology.

This project report will focus on the experiences and results of those two "early adopters" over the past three years. Baseline data were gathered in 1991 that documented early implementation issues encountered by those professors and their students. Subsequent data have been collected in 1993 through student questionnaires, observations, and interviews with the professors and their students. Results suggest that while impediments to implementation of technology still exist, many have been eliminated or minimized. Data gathered from students suggest that effective integration of technology is extremely motivating and enhances their achievement of course objectives. Interview data confirm these findings and suggest faculty are motivated as well by the increased use of technology.

This project presentation will elaborate on the results outlined above and discuss the implications for further efforts toward widespread implementation of technology in all college offerings.

Project (T1-313B)

Technology Planning in America's Schools: A Status Report

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Key words: planning, infusion, integration

Abstract

Technology planning, when conducted properly, can enhance significantly the extent to which students, teachers, and administrators use computers and related technologies to solve routine problems. Further, with good planning, people's imaginations and creative energies can be unleashed to achieve new vistas that spurn new growth.

Questions arise regarding the extent to which schools in the United States are engaging in appropriate planning activities. Schools at the beginning phase of the planning cycle may not recognize the broad spectrum of planning activities. Efforts by the National Center for Technology Planning (NCTP) at Mississippi State University have been directed at discovering what types of planning are underway, where planning is occurring, and the extent to which institutional goals are being met.

NCTP research, although incomplete, has indicated that approximately 30 percent of America's schools have a technology plan. Others have a document they *called* a technology plan when it was first written; now they realize it is little more than a compilation of words and statistics having little or no positive impact on instruction. Hundreds other schools and districts are engaged in various phases of the planning process currently, with hopes of producing an effective technology plan.

Technology plans from one state, for example, include instances in which the district name appears as "Anywhere School District" in the document. This travesty results from their having used a word processing template in a commercially-available technology planning kit; they simply used this resource without making the plan truly *theirs*. These documents cannot be tallied in the count of districts that have a technology plan.

Educators welcome success stories. Certainly, when a school district sees its plan unfolding in reality, there is cause for celebration. Marilyn Fricks, Technology Coordinator for Humble (TX) ISD, stated that it would have been much easier for her to write the plan alone; the plan became immensely more effective, however, when people representing all aspects of the school community gathered to shape plans for implementing technology. Subsequently, teachers have become engaged in extremely meaningful professional development activities that enhance their classroom operations, supported by technology, of course.

Interesting trends are developing that should shape planning efforts. As a result of encouragement from the growing number of planners who have "rolled their own," as opposed to using templates provided in commercial kits, educators beginning the planning process are taking a closer look at their curriculum, the interactions among components in their school, and the support systems available to them. Improvement of the *process* yields better long-term benefits. The Technology Planning Team in Mountain Brook, AL, schools evaluated technology plans in the NCTP repository as one component of their developing process. This led them to offer numerous opportunities for community members to voice opinions about how they viewed the school's future—because of the *process*, a new body of supporters emerged who, previously, did not realize that their feelings were of value to or would be accepted by the school. A real, legitimate partnership is being formed there.

Based upon informal interviews with technology planners in schools throughout the nation, NCTP personnel envision a gratifying future for technology planning. Fresh examples are emerging that demonstrate the power of sharing. Schools involved in the sharing network are discovering methods of evaluating their technological needs, modifying their implementation strategies in mid-stream, and recognizing new visions of possibilities. As they participate in the network, they share what they have learned. Others profit from the continuous flow of reflective observations. Peer evaluations increase in frequency. Remarkably, as the frequency of sharing increases, so does the quality of planning documents.

Project (T1-313C)

Curriculum+Technology+Integration = Revolution

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Key words: curriculum, integration, technology, development

Abstract

Plano ISD has created a facility within the administration building to function as a curriculum development center (CDC). This space houses thirty classroom teachers (K-5), six coordinators, and six consultants on a daily basis. Teachers use computers and other technologies to develop and implement the new curriculum. The integrated curriculum consumes two hours per school day. Classrooms have been equipped with various technologies to allow students to work through the new curriculum.

The Plano Project

Plano Independent School District is in the process of integrating curriculum and technology into a meaningful whole. It is believed that appropriate blending of effective teaching techniques, content, and technology will produce successful classroom experiences for students. To this end, Plano initiated the Curriculum Integration Project. This project involves the following components: Curriculum, Technology, and Staff. These three are blended in a facility housed in the central administration building (called the CDC Curriculum Development Center).

The CDC consists of thirty classroom teachers (five from each grade level K-5), six elementary coordinators (one per grade level), six Edunetics personnel (one per grade level) , and a district project manager. These teachers meet in the CDC each afternoon from 1:00—4:00 Monday through Thursday to discuss and plan the curriculum. Fridays are for the teachers to work in their buildings on integrated activities. Each teacher has a co-teacher that reports to the school at 12:00. The teachers develop in the CDC, pilot their ideas in their classrooms, and revise work in the CDC.

To prepare for the development, teachers and coordinators studied the brain research of how students learn through making connections. Based upon this research, the team devised seventeen lifelong learner traits within six categories (self-directed learners, effective communicators, complex thinkers, quality producers, responsible citizens, and collaborative contributors). The emphasis is on students "learning how to learn" rather than on "covering material".

The curriculum design calls for an integrated block of curriculum to last about two hours of the school day. The major elements of this design include overarching concepts (These link broad, universal ideas to theoretical structures. They serve as strands that connect concepts and facts within disciplines and across disciplines.), organizing ideas (These reflect the overarching concept and provide a unifying frame for sequences of related learning experiences in various disciplines.), introductory unit (This unit creates engagement by providing relevance and purpose for the student.), content investigation unit(s) (These units provide in-depth exploration of concepts and processes related to the organizing idea through different disciplines.), and culminating demonstration (This unit provides application and synthesis of learning in a significant performance context in which "real-world" problems have been presented to students for solution. They connect what they learn in class to the outside world.) Teachers use the technology to both develop and deliver the new curriculum. Each area in the CDC has a computer for each teacher, a modem, and phone. In addition there are VCR and video disc players for their use. In each classroom (thirty), the district provided 6-8 networked computers, a large screen monitor, a VCR, a video disc player, a modem, a phone, and a machine for the teacher to use for demonstrations. There are several tool applications and instructional software programs installed on the server.

This project is to be developed over a three year period. The task is to write about two organizing ideas (OI) each year. This will result in six OI's per grade level by the end of the project.

Paper Symposium (T2-201A)

Computer Support for Collaborative Learning: Revolutionary Configurations of Students, Teachers, Curriculum, and Technology

Discussant:

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Key words: software design, CSCL, collaborative learning, problem-based learning, groupware

Symposium Abstract

Historically, software (both instructional and otherwise) has been designed for use by individuals. Recently, however, researchers have begun to investigate the practices and artifacts by which groups coordinate their work with an interest in the development of new facilitating technologies. Workers have focused on the development of "groupware" to augment interactions among members of a collaborative learning group. This emerging paradigm of study has come to be known as "Computer Support for Collaborative Learning" (CSCL).

This symposium will feature presentations on four prominent CSCL projects. In the first paper, Peter Rowley describes the CSILE program developed at the Ontario Institute for Studies in Education (OISE). CSILE is a shared database system that enables students to view, critique, and amend research reports submitted by their peers. His paper compares CSILE's supports for collaboration with those of other networking technologies, such as file sharing, providing a clearer view of how specific designs can encourage or discourage collaboration. The Edelson and O'Neill paper describes one aspect of the Collaborative Visualization (CoVis) project. The CoVis project, a cooperative venture of Northwestern University and several other educational and industrial partners, focuses on the use of high-speed telecommunications technology to support collaboration across dispersed sites. The paper by Bruckman will describe research being performed at MIT Media Lab. Bruckman will discuss her work using multi-user virtual worlds on the Internet called "MUDs" as a context for self-motivated learning of reading, writing, and programming. The last paper by Ryan and Koschmann describes tools that have been developed at Southern Illinois University to support groups of medical students learning in teams in the context of a collaborative method of instruction known as Problem-Based Learning.

Following the presentations, Elliot Soloway (serving as discussant) will highlight some of the common themes from these papers and will indicate directions for future work.

Programming for Fun: MUDs as a Context for Collaborative Learning

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Key words: collaborative learning, computer networks, MUDs, virtual reality

Abstract

In text-based virtual reality environments on the Internet called "MUDs," participants meet people from all over the world. They can not only explore the virtual world, but extend it, creating new objects and places. MUDs are Constructionist

environments in which people build personally meaningful artifacts. But unlike many Constructionist environments, MUDs place special emphasis on collaboration, encouraging construction within a social setting.

This paper presents a case study of the experiences of a 43-year-old building contractor named Jim. It is one of an ongoing series of interviews I have conducted with people who learned to program for the first time in a MUD called MediaMOO. Salient features of their learning experiences include ease of collaboration, availability of technical assistance from peers, playfulness, availability of an audience for completed work, and community spirit. The success of MUDs as a learning environment for adults points to its potential as a learning environment for children.

Introduction

Jim is a 43-year-old building contractor who lives in the Pacific Northwest of the United States. He built a "77 Jeep Cherokee." Susan is a thirty-eight year old professor of agriculture from the South. She built a simulation to help her students learn to perform certain laboratory procedures. Christopher is a 23-year-old graduate student in comparative literature in South Africa. He programmed a poetry generator. Neil is a 30-year-old graduate student in American cultural studies in the Midwest. He built a "RetroFuturist Aerodrome" complete with a biplane, a blimp, and a taxi stand for those who want to catch a ride. Two men named David—a writing teacher from the Western United States and a graphic designer from the Midwest—each programmed a box of donuts.

Although they are spread out geographically, they talk to one another daily in a virtual community on the Internet called "MediaMOO."[1] MediaMOO is a text-based multi-user virtual reality environment or "MUD" based on software written by Pavel Curtis of Xerox PARC (Curtis 92). None of these people had ever programmed before they came to MediaMOO. Their accomplishments are diverse, from Susan's elaborate simulation system to David and David's completion of a simple tutorial. However, they were all inspired to try to learn to program by the same factor: a desire to contribute to the community. They were all supported in their efforts by the presence of other people in the virtual world to ask for help. In these worlds on the network, learning is a collaborative, community activity.

This paper will begin by explaining the underlying technology, and then present in depth the case study of Jim, the building contractor mentioned above. In conclusion, it will analyze the potential of these virtual worlds as a learning environment for children.

What is a MUD?

A MUD is a text-based multi-user virtual-reality environment. As of December 1993, there were 424 publicly announced MUDs based on twenty-one different kinds of software on the Internet. I will use the term "MUD," which stands for "Multi-User Dungeon," to refer to all the various kinds.[2] The original MUDs were adventure games; however, the technology has been adapted to a variety of purposes.

When a person first logs onto a MUD, he or she creates a character. The person selects the character's name and gender, and writes a description of what the character looks like. It is possible for a character to be male or female, regardless of the gender of the player. In many MUDs, a character can also be neuter or even plural. A plural character could, for example, be called "swarm_of_bees" or "Laurel&Hardy."

MUDs are organized around the metaphor of physical space. You can "talk" to anyone in the same virtual room. When you connect to MediaMOO (our MUD at the Media Lab), you see the description:

```
>connect guest
Okay,... guest is in use. Logging you in as `Green_Guest'
*** Connected ***
The LEGO Closet
It's dark in here, and there are little crunchy plastic
things under your feet! Groping around, you discover what
feels like a doorknob on one wall.
Obvious exits: out to The LEGO/Logo Lab
```

The core of MediaMOO is a virtual representation of the MIT Media Lab. Typing "out" gets you to the "LEGO/Logo Lab," a central work area for the lab's Epistemology and Learning (E&L) research group:

```
>out
The LEGO/Logo Lab
The LEGO/Logo Lab is a happy jumble of little and big
computers, papers, coffee cups, and stray pieces of LEGO.
```

```
Obvious exits: hallway to E&L Hallway, closet to The LEGO
Closet, and sts to STS3 Centre Lounge
You see a newspaper, a Warhol print, a Sun SPARCstation IPC,
Projects Chalkboard, and Research Directory here.
Amy is here.
>say hi
You say, "hi"
Amy says, "Hi Green_Guest! Welcome!"
The Thin Blue Line arrives and slows to a stop.
The conductor of The Thin Blue Line cries, "Next stop is
Ballroom Foyer."
The conductor of The Thin Blue Line cries, "All aboard!"
The Thin Blue Line moves out slowly, gathering speed as it
vanishes into the distance.
```

In this transcript, a guest connects and speaks with a real person (me). Each person could be anywhere in the world with an Internet connection. Although I live in Boston, there are people in California, England, Austria, and South Africa who are part of my daily life. As Green_Guest and I were talking, a train came through. If Green_Guest were to type "enter train," it would give him/her a tour of interesting places around MediaMOO. The train system was programmed by a MediaMOO user named "Moose"4 who is a graduate student at Brown University.

The earliest MUDs were written in 1978-1979 and were based on the role-playing game Dungeons and Dragons. In 1989, a graduate student at Carnegie Mellon University named James Aspnes decided to see what would happen if the monsters and magic swords were removed. He created a new type of MUD, called "TinyMUD," which was not an adventure game. Later versions included a simple programming language. Instead of spending time killing virtual monsters, participants work together to help extend the virtual world. Langdon Winner remarks that "social activity is an ongoing process of world-making" (Winner 86). In MUDs, this is true in a literal sense.

In most MUDs, characters are anonymous. People who become friends can exchange real names and E-mail addresses, but many choose not to. Conventions about when it is acceptable to talk about "real life" vary between communities. In most MUDs, people begin to talk more about real life when they get to know someone better. However, in some communities such as those based on the Dragonriders of Pern series of books by Anne McCaffrey, talking about real life is taboo.

MUDs are increasingly being used for more "serious" purposes. David Van Buren of the California Institute of Technology and Pavel Curtis of Xerox PARC has developed a MUD to enhance professional community among astrophysicists called AstroVR (Curtis and Nichols 93). The MediaMOO project, which I began in fall of 1992, is designed to enhance professional community among media researchers (Bruckman and Resnick 93). As of February 1994, MediaMOO had over 900 participants from twenty-three countries.

In my dissertation research, I plan to create a MUD called "MOOSE Crossing"5 as a learning environment for children. The research presented in this paper is part of a pilot study to explore the potential of MUDs as an authentic context for learning to read, to write, and particularly to program.

Why Learn Programming?

Implicit in this work is an assumption which should not go unexamined: that learning to program is beneficial. In asking this question with regard to children, a certain degree of futurism is in my opinion appropriate: in the future, programming will most likely give them more control over their lives in our increasingly information-based society. Comfort with computers may make new careers available to them. Overcoming technophobia will make them better consumers and better citizens.

This seems appropriate for children, but does it apply to the adults described in the introduction to this paper? For example, the 43-year-old building contractor, Jim, is unlikely to incorporate computers into his business any more than he already does. However, he has found in programming a new outlet for creative expression. It has inspired him enough to want to share that knowledge with his children's teachers. The next section presents Jim's story in depth.

"This has inspired me"

Jim is one of twelve adults who learned to program in MUDs (eight on MediaMOO) who I have interviewed to date. I spoke with him both on the phone and on MediaMOO.

Jim has always lived in the Pacific Northwest of the United States. After he was graduated from high school, he was drafted into the army. By a stroke of luck, he narrowly avoided being sent to Vietnam. After two years of military service, he attended two years of junior college on the GI Bill. He took what he describes as "just the fun classes" and never got a degree. In need of work, he learned that a friend of a friend needed help building a house. After a number of years, he built up enough expertise to start his own building contracting business. Jim has little mathematical or scientific background, and had never programmed before he encountered MediaMOO:

> I work on a computer at home. I don't have it in an office, at school, or anything like that. We use a Macintosh. My wife was a graphics designer and she needed a computer to stay in her field. I'm a building contractor. She bought a Mac about four years ago and started doing design on the computer, and I started using it for my business, just playing with it, and really liked using it.

Asked why he decided to try programming, Jim describes a desire to contribute to the community:

> Since I started getting involved with this I became interested in programming because I wanted to be able to manipulate this world in a better way. And instead of just looking at things and creating things that already existed, I wanted to try and put my hand to actually creating something of my own.

By "creating things that already existed," Jim is referring to the fact that since the MOO is object-oriented, it is easy to make useful objects simply by making something which inherits from an existing parent object. You can make a television set with one simple command, making something which inherits from generic television set. Making something which inherits from an existing parent object is an easy first step towards programming. It is part of what encourages people that they can and would like to make something of their own.

Jim also describes the MOO environment as an interactive story to which he wants to be able to contribute:

> It's like reading a story that I get to help write. And I wanted to get more input into what was happening, beyond just chatting with people and creating a box or whatever… I wanted to try and do something with it.

The community of learners present on MediaMOO was one of his key motivations for learning to program. He wanted to be able to contribute something to that community. Objects are conversation pieces in MUDs. When Neil flies by in his blimp, others stop to admire it and ask him how he created it. That becomes the basis for striking up a conversation, rather like dog owners in a park being able to strike up a conversation about dogs and then segue to other topics. Jim wanted to build something of his own rather than simply admiring everyone else's work. This combines a desire for personal mastery and elevated personal status with a desire to contribute something to a society he has benefited from. Other residents of the virtual world form an audience for work. People's motivations for trying to program something are primarily social.

The first step in learning to program is perhaps the hardest. The initial barrier is primarily emotional. Most adults who do not have formal technical education suffer from some degree of technophobia. On MediaMOO, a user named "cdr"[6] made a set of clear, simple tutorials. Seven of the eight MediaMOO programmers interviewed to date began by doing one of these tutorials. Susan comments that for her, the tutorials' primary function was to help her overcome that initial emotional barrier: "I did cdr's tutorials and I realized 'I can do this!' But then I had to step back and figure out what it was that I had done."

Cdr began by programming a "television set" object. You can turn on your television set and receive different "programs" on different channels. One of the first shows he added to the television schedule was called "Coding with cdr," an instructional video teaching you how to program a box of donuts that you can eat. The metaphor of an instructional video seems to put people at ease. The success of these tutorials also depends on cdr's friendly, warm personality. His manner puts people at ease. They are not detached technical instructions, but help from a caring, supportive person. Jim enjoyed doing the tutorials:

> I'm totally program-language illiterate. Well, I found cdr's tapes. Cdr was able to lay out exactly what was going on and lay it out step by step—you watch his tape, and you do what he says. And it worked! I was able to start to understand what the basics of it was all about. I made his box of donuts, and then I made myself a car to drive around in. And I added some events so I personalized it somewhat. I really enjoyed that.

Jim was excited enough about his car to want to port it over to another MOO where he has an account, PostModern Culture MOO (PMCMOO).7 He discovered that one of the needed parent objects for the car, generic portable room, did not exist on PMCMOO. In solving this technical problem, he relied on the help of other members of the community:

> I got excited about programming just by making cdr's car and doing those things, to where I went back to the other MOO where I had an account and made myself a vehicle there from scratch. Cause they didn't have portable rooms there. I had help, of course. I got a couple people who knew more than me to give me a hand when I got stuck. Being in the MOO enables you to be… two people can work on the same project at once. I could work on my verbs, and when I had a problem I would call somebody over, and they could just list it out and they could say "gee, you need to do this" or "you need to do that." It was just like having someone sitting behind me at my terminal critiquing what I was doing.

Just as the community provided Jim's initial motivation for learning to program, it also provided support to help him through the process. In a MUD, you are never alone. If you have a technical problem, there are other people there to help you. Helping others is a central activity in MUD culture; it is a basis on which strong friendships are formed. People often speak warmly of those who helped them through technical difficulties.

Asked to compare programming a computer to programming his VCR, Jim says he finds the former easier:

> Programming a VCR is not like programming code. If I was programming a verb8 or something it's all right in front of me, the words are right there. On a VCR you have to have every wire connected properly. You have to know what all these buttons do. And it doesn't respond. You don't type in a word and see it on the screen. It's kind of like doing something in the dark—trying to type words in the dark.

Jim was inspired enough by his programming experiences to want to share them with teachers at his children's school:

> I plan on bringing high school kids online. I'll be working with a high school this fall. We're just getting the Internet connection. What I'm trying to do is get the teachers interested. I mean they're all interested in Internet because of all the research and all the facts that can be gleaned from there. But I also want to introduce them to the MOO just because it gets people excited about programming.

"This has inspired me," says Jim. He explains that he has just enrolled in a programming course at his local university's extension school.

Community for Learning

For Jim, the online community functions as:

- Motivation for learning
- Emotional support to overcome technophobia
- Technical support
- An appreciative audience for his work

While this paper has focused on learning programming, MUDs are also a supportive learning environment for creative writing for the same reasons.

At the conclusion of Mindstorms, Seymour Papert has a vision of a technological Samba school—a place where people of all ages are playing and learning together (Papert 80). I believe that MUDs may be a step towards realizing that vision.

Future Directions

The success of this learning environment for adults points to its potential as a learning environment for children. For my dissertation, I am creating a MUD for kids called MOOSE Crossing. "MOOSE" stands for "MOO Scripting Environment." I am developing a new programming language built on top of Pavel Curtis' MOO software. The MOOSE language builds on lessons learned from Logo, Hypertalk, and CLOS to create a language that I hope will be easier to use.9

The children themselves will build the world of MOOSE Crossing. I will simply set up areas with different themes where they can attach their creations—a town, a city, a place for different types of ecosystems, a place for different fantastical creations and themes from popular culture. My hope is that the same features which made Jim's experience successful will create a powerful learning experience for kids.

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The CoVis Collaboratory Notebook: Supporting Collaborative Scientific Enquiry

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Key words: collaboration, distance learning, hypermedia, project science, scientific visualization

Abstract

The Collaboratory Notebook is a networked hypermedia database that allows students to collaborate on scientific inquiries across boundaries of time and space. Developed as part of the CoVis networking testbed, this software expands upon the traditional laboratory notebook. In the Notebook, users express their ideas, record their actions and respond to others in a medium that is structured specifically for the task of scientific inquiry.

Introduction: The CoVis Project

The Learning Through Collaborative Visualization (CoVis) Project is an NSF-sponsored networking testbed designed to explore the use of new computing and communications technologies in support of project-enhanced science learning. The goal of CoVis is to provide high school students with opportunities to learn about science by engaging in scientific inquiry themselves. In achieving this goal, the CoVis project focuses on three themes: ***project-enhanced science learning***, ***scientific visualization***, and ***collaboration***.

Project-enhanced science learning (Ruopp, Gal et al. 1993) represents a transition from traditional textbook- and lecture-oriented classrooms to ones in which learning occurs in the course of scientific inquiry. In this approach to pedagogy, students play an active role in formulating research questions and pursue them in collaboration with their peers, teachers and scientist mentors. In the process of these investigations, students acquire a deeper understanding of the subject matter addressed, and learn other valuable lessons about how scientific inquiry is accomplished.

An important principle behind project-enhanced science learning is that the study of science should more closely resemble the practice of science by scientists. To make this possible, students must be able to conduct investigations similar to those of scientists, using similar tools. The second theme of the CoVis project, scientific visualization, is designed to place tools used by scientists in the hands of students. Scientific visulization plays an increasingly important role in many fields of science, including the atmospheric sciences. As a part of its overall effort, the CoVis project has adapted visualization tools used by scientists to be appropriate for use by high school students in earth and environmental science courses (Gordin, Polman and Pea, 1994; Fishman and D'Amico, 1994).

The third theme of the CoVis project is collaboration. Modern scientific workplaces are connected and collaborative in nature (Finholt and Sproull 1990; Lederberg and Uncapher 1989). In the atmospheric sciences particularly, researchers are making use of high-speed digital networks to support collaborations that span large distances (D'Amico, Fishman, Gordin, McGee, O'Neill and Polman, in preparation). To reflect this development in the high school learning environment, CoVis takes advantage of an advanced ISDN digital network to link its two participating high schools to Northwestern University, the University of Illinois at Urbana-Champaign, and the Exploratorium science museum in San Francisco. The goal of this network and the collaboration software that we provide is to allow students to work together with other students and to form informal mentoring relationships with professional scientists.

The Collaboratory Notebook

The Collaboratory Notebook is a networked application which has been designed to directly address the central goals of the CoVis project. Specifically, it is intended to:

- scaffold the inquiry process for students who have never performed independent inquiry before;
- integrate scientific visualization with other computer- and non-computer-based activities;
- provide a means for collaboration among participants who may be spread across institutions and across the country.

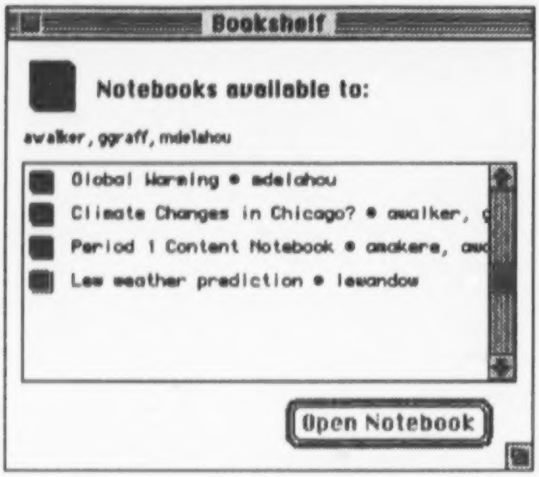
The design of the software reflects an attempt to address many of the challenges that project-enhanced science learning entails, both for students and teachers. Many of the students who make use of the software have never conducted independent research before, are unaccustomed to recording their thoughts and actions for future reference, and are unfamiliar with the structure of scientific arguments. The Collaboratory Notebook is an important part of the CoVis project's overall effort to encourage students to record and reflect upon the process of scientific inquiry, including false starts, missteps, and the redefinition of problems.

Teachers managing a project-centered science classroom must confront the general tendency in science education to product over process. By helping make more informal, intermediate products of students' work available to teachers and scientist mentors, the Collaboratory Notebook can serve as a technological lever to help teachers monitor student's learning processes. It can also encourage innovative assessment routines by eliminating the need for teachers to collect and grade their students' work *en masse* . Instead, a teacher can review electronic notebooks in an ongoing fashion that is more appropriate for guiding independent research.

The Structure of the Collaboratory Notebook

The Collaboratory Notebook is a medium for students to record their thoughts and actions as they perform scientific inquiry. Many of its facilities have been inspired by other communal databases for learning such as CSILE (Scardamalia and Bereiter 1991; Scardamalia, Bereiter et al. 1989), INQUIRE (Brunner 1990), and GroupWrite (Schank and Osgood 1993). However, the Collaboratory Notebook has many unique features of its own which arise from the large distributed community that it was created to support.

The Notebook's interface is built on the metaphor of a library; with bookshelves, notebooks and pages being the primary interface elements. When a student or teacher logs on, a bookshelf displays all of the notebooks to which that individual has access (Figure 1),.



awalker, ggraff, mdelahou

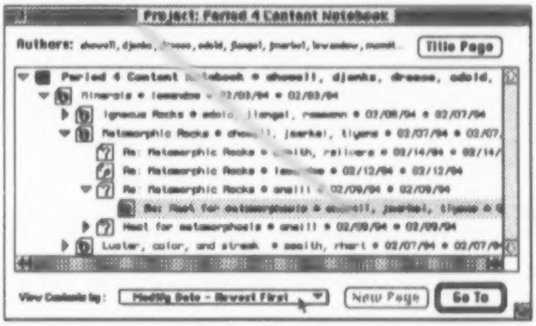
- Global Warming • adelahou
- Climate Changes in Chicago? • awalker,
- Period 1 Content Notebook • amakere, aw
- Lew weather prediction • lewandow

Figure 1. A Bookshelf. The color and letter on the icons at left indicate whether the notebook is a journal (J), project notebook (P) or discussion (D).

Notebook users can create three different types of notebooks. They are:

- **Private Journals.** A private journal can only be read or modified by its single owner.
- **Project notebooks.** A project notebook is shared by a group of individuals, all of whom may read or modify it. A project notebook provides a medium for a group of students, teachers and scientists to share inquiry.
- **Discussions.** A discussion is open to any member of a community. Discussion notebooks provide a medium for public dialogue among students, teachers, and scientists on a topic of mutual interest.

All of the notebook types share the same structure. A notebook consists of a title page with a brief description of the notebook's purpose, a table of contents, and any number of content pages. The table of contents for a notebook displays the notebook's title, a list of its authors, and an overview of its pages, including their types, titles and relational structure. The table of contents for a Project notebook is shown in Figure 2.



Project: Period 4 Content Notebook
Authors:
Title Page
View Contents by:
Modify Date - Newest First
New Page
Go To

Figure 2. The table of contents for a whole-class project notebook.

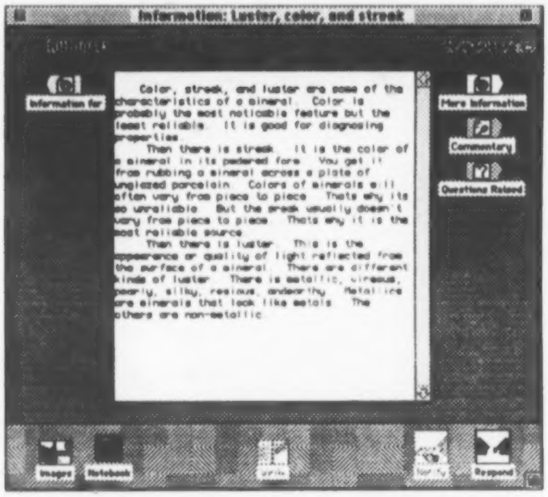
Each page in a notebook has a type (indicated by its icon), a title, and a set of authors. Pages may be authored by individuals, or by a group of people working together at the same time. The types given to pages by their authors provide both a description of their contents, and of their relationship to other pages. The page types available to choose from in the current version of the software are:

- **Information**. An information page can describe an experience, or offer some knowledge that is seen as useful to the investigation.
- **Commentary**. A commentary page offers a view on what has been written in another page, or suggests a direction for future investigation or discussion. Commentaries are useful for feedback and guidance from instructors.
- **Question**. A question page can be used to record one or many questions. These could include a response to the contents of another page or central research questions.
- **Conjecture**. A conjecture page is used to record hypothesized answers to questions in a notebook.
- **Evidence for**. An evidence-for page is used to provide justification for a conjecture. Evidence might take the form of scientific visualizations, information gathered from outside sources, or logical arguments.
- **Evidence against**. An evidence-against page contains evidence that contradicts a conjecture.
- **Plan**. A plan page records a plan for answering a question or verifying a conjecture.
- **Step in plan**. A step in plan is a page for recording the process and results of carrying out one step in a plan.

Notebooks are created by linking pages together in accordance with the structure of an inquiry.

Browsing and Authoring Pages in a Notebook

Because the Collaboratory Notebook is used for both reading and writing in the course of an investigation, it has been designed to support both activities equally well. Figure 3 shows a notebook page as it appears when it is being read.



Color, streak, and luster are some of the characteristics of a mineral. Color is probably the most noticable feature but the least reliable. It is good for diagnosing properties.

Then there is streak. It is the color of a mineral in its powdered form. You get it from rubbing a mineral across a plate of unglazed porcelain. Colors of minerals will often vary from piece to piece. Thats why its so unreliable. But the streak usually doesn't vary from piece to piece. Thats why it is the most reliable source.

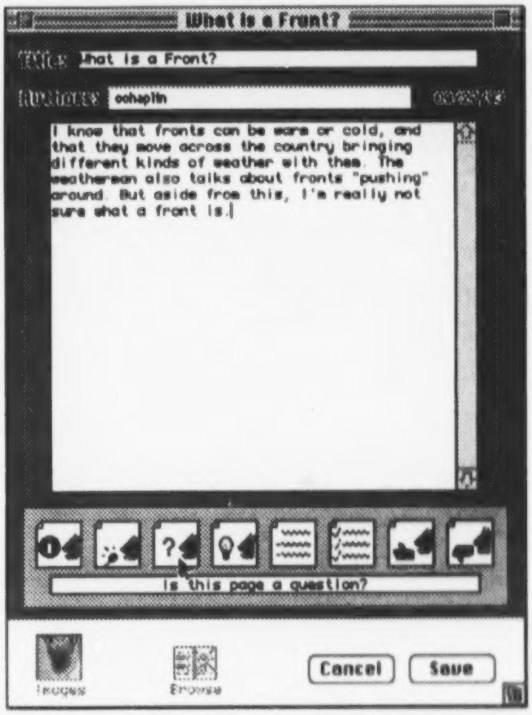
Then there is luster. This is the appearance or quality of light reflected from the surface of a mineral. There are different kinds of luster. There is metallic, vireous, pearly, silky, resinous, andearthy. Metallics are minerals that look like metals. The others are non-metallic.

Figure 3. A question page from a project notebook.

The top of a notebook browsing window displays its title, its authors' names, and the dates it was created and last modified. On the right and left sides of the window are arrow-shaped buttons representing links that connect the page to others. On the left is an icon representing links *to* the displayed page from other pages that inspired it, and on the right are icons representing links *from* the displayed page to other responses. In other words, the Collaboratory Notebook maintains the convention that links between pages come from the left and go to the right.

When a user clicks on one of the arrow buttons with the mouse, she is presented with a list of pages of one particular type that are linked to the current page. For instance, if the user clicks the "questions raised" button, she sees a window displaying a list of pages containing questions in response to the page she is reading. She can then select any one of these questions to view, or can respond with a new question of his own.

To inform a reader, the background color of each arrow button changes to indicate how many pages of that type are linked to the current one. For example, if a question page has no conjectures attached to it, the background of the conjectures icon will be white. Once a user attaches a conjecture to this page, the background of the conjectures icon will change to a light shade of yellow. As more conjectures are added, the color changes to increasingly dark shades.



What is a Front?

ochaplin

I know that fronts can be warm or cold, and that they move across the country bringing different kinds of weather with them. The weatherman also talks about fronts "pushing" around. But aside from this, I'm really not sure what a front is.

Is this page a question?

Figure 4. A question page being edited. The user classifies the page by clicking one of the icons in the lower section of the window.

When a page is being created or modified, it appears in a different form (Figure 4). The band of icon buttons near the bottom of the page writing window provides authors with options for classifying the page they are working on. This classification may be changed repeatedly as the authors' sense of what they have written and its place in the inquiry evolves; however the software requires that the user select a type for each page before saving it.

A Supporting Structure for Collaborative Inquiry

The particular outgoing link types that a page may have are determined by the type of that page, according to a process model of inquiry. To give an example of how this model applies, a Conjecture page may take Evidence-for and Evidence-against pages as responses, but a page that describes a Plan for an investigation may not. All page types haveoutgoing links for questions raised, more information, and commentary. These are known as ***universal links***.

Page Type	Response Palette
? Question	Information, Question, Commentary, Conjecture, Plan

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Conjecture	Information, Question, Commentary, Plans, Evidence For, Evidence Against
Plan	Information, Question, Commentary, Step in a Plan

Figure 5. Response palettes available for Questions, Conjecture and Plan pages.

The page types and response palettes supported in the notebook have been chosen to help students give structure to inquiry by focusing on small, but necessary intermediate products. Employing a small, fixed set of page and link types offers two significant advantages. First, it provides students with a framework for conducting dialogue which is tailored to the task at hand. Second, it helps to encourage consistent conventions of use across the larger community which CoVis supports.

The structure of the notebook helps students to structure their inquiry through its interface. When a student has created a notebook entry from scratch, the Notebook prompts her to characterize it. Is it a question, a comment, information, a conjecture, or a plan? When a student reads a page, the interface reminds her of ways that she might choose respond to it. For example, if she's reading a conjecture, the display of that conjecture reminds her that in addition to raising questions, commenting, or adding information, she might respond by providing evidence for or against it. Similarly, when she's reading a question, she is reminded that she could propose a conjecture about that question or a plan to research an answer. Table 1 shows the response palette available from three types of notebook pages.

The utility of this scheme is that by creating a number of pages, each containing only a small amount of writing, a student can create a large, complex investigation in a stepwise fashion that makes the relations of the individual parts explicit. The collaborative nature of the work supported by the notebook means that participants can reflect directly upon each part, encouraging the authors to clarify or extend their contributions.

A second reason for using a small, fixed set of page and link types is that they lead to helpful conventions of use for the tool. These conventions will enable our large community of users to develop expectations about the contributions of others. In the few months in which the Collaboratory Notebook has been in use, we have already seen sets of conventions arise for the revision of successive drafts of students' project proposals, the organization of knowledge gained by students from interviews with experts, and the sharing of responsibility between teachers and graduate students for mentoring groups of students. Within these conventions, the small number of page types makes the selection of an appropriate type for a page nearly automatic; and the fact that the set of types is fixed allows students, teachers and scientists to develop expectations that are useful in reading the work of others. If students were free to create their own page and link types, one student reading another's work would not be able to form reliable expectations about the semantics of any particular link or page type.

Integration of the Notebook with Scientific Visualization

Scientific visualization tools are an important element of the CoVis software suite. To assist students in recording their inquiry and sharing in the inquiry of others, the Collaboratory Notebook is tightly integrated with these visualization tools . Each of the tools generates an automatic log of users' actions. Using standard Macintosh cut and paste operations, students can place sections of these activity logs into appropriate pages in their notebooks and elaborate upon these terse computer-generated logs with more extensive descriptions of the context in which those actions were taken, their purpose and results. In addition, students may attach images created by the visualization software or a painting program to any notebook page. These images can be titled and annotated to reflect their role in an investigation.

Collaboration Using the Notebook

The Collaboratory Notebook has been designed to support both synchronous and asynchronous collaboration. Shared project notebooks and discussions allow for participants anywhere on the Internet to contribute to an inquiry. Authors can be added to and removed from a notebook at any time to accommodate the dynamic nature of collaborative project groups. Within the classroom, several individuals can be logged into the notebook at a time, so that students can work together simultaneously at one computer. Any pages that are created in a multi-user session bear the names of all the users as authors. Also, since the CoVis software environment allows two users at separate computers to share one screen[1], authors at different locations can work as if they were sitting at the same keyboard, regardless of the distance that separates them.

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[1] Screen-sharing in the CoVis environment is supported by Timbuktu and Timbuktu Pro from Farallon Computing.

Use of the Collaboratory Notebook

At the time of this writing, the Collaboratory Notebook has been used by teachers and students in 5 Earth Science classes at Evanston Township and New Trier High Schools in suburban Chicago. Together with the CoVis team, these teachers are continuing to explore its uses within the large CoVis community, which includes over 300 students, teachers, educational researchers, and research scientists. An analysis of some of the uses made of this tool, and lessons learned from them, are presented elsewhere (O'Neill and Gomez, 1994).

Acknowledgments

The authors would like to thank all of the CoVis team members and teachers for the contributions they have made to this research at every stage. In particular, we would like to thank Myrland J. Gray, the Collaboratory Notebook's lead programmer.

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Collaborative Technology for Revolutionary Classroom Structures

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Abstract

The CSILE (Computer-Supported Intentional Learning Environment) System is an advanced computer-supported cooperative learning system being developed at the Ontario Institute for Studies in Education. Over the last seven years, this system has been iteratively refined by working closely with teachers and students engaged in creating an educational approach called "knowledge-building". Used with this approach, CSILE has demonstrably positive effects on standardized test scores and a variety of measures of deep understanding. We give a brief overview of the principles that guided development of the system and some of its facilities and conclude with a comparison of CSILE and the Apple Macintosh AppleShare™ 3.0 file server with respect to their support for classroom collaboration.

Introduction

Networked computer systems have a great potential to revolutionize how classrooms are organized and the extent to which they succeed in helping produce aware and intelligent citizens capable of contributing in the 21st century world of "knowledge work" (Marshall 92). Unfortunately, many networks are structured to emulate the organizational patterns of traditional classrooms, despite the known limitations of these patterns (Resnick 89).

In a teacher-centered traditional classroom, the primary flow of knowledge is from the teacher to the students (see Figure 1). On occasion, students are prompted for evidence that they have absorbed the content delivered previously by the teacher.

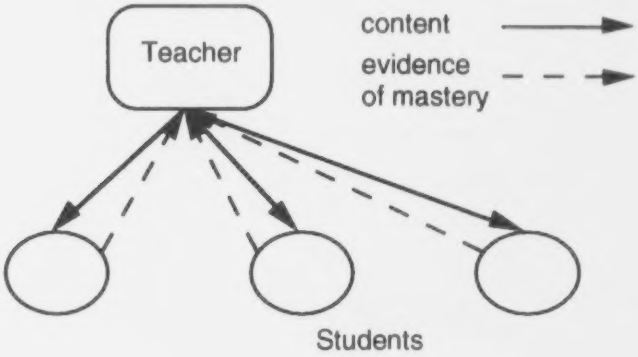

Figure 1.

Integrated learning systems (Merrill 92) typically emulate this structure, replacing the teacher with a file server of lessons, the student's desk with a workstation, verbal delivery of content with network delivery, and classroom question-and-answer with automated testing. The ILS has the advantage of allowing students to proceed at their own pace, and multimedia ILS systems may appeal to a broader variety of students by virtue of their appealing graphics, video, and animation, but users of these systems typically gain little or no experience in research skills or collaboration, both of which are central to knowledge work.

For the last seven years, the members of the CSILE™[2] Project at the Ontario Institute for Studies in Education[3] have been developing a different model of classroom organization, called collaborative knowledge-building, and a computer system to support it, called the Computer-Supported Intentional Learning Environment (CSILE, pronounced "SEE-sil"). Used in over a dozen schools across North America in grades 1-12, with an emphasis on grades 5 and 6, it has been shown to positively affect a variety of measures (Scardamalia 92), including performance on standardized language skills tests and comprehension of difficult text. The approach and the system are based on several principles (Scardamalia 89, 93), including :

- Deep understanding comes when students actively bring new knowledge into contact with their own preconceptions, so that contradictions surface, leading to conceptual change as they construct their revised knowledge.
- Knowledge workers must be skilled at organizing their own pursuit of understanding, and therefore students must gain experience in this arena. This involves such activities as identifying gaps and

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[2] CSILE and MacCSILE are registered trademarks of the Ontario Institute for Studies in Education.

[3] This work has been supported by the Government of Ontario (via the Ministry of Education, the University Research Incentive Fund, and the OISE transfer grant), the Social Sciences and Humanities Research Council of Canada, Apple Computer Inc. (External Research), Apple Canada, IBM Corporation (Advanced Workstation Division), and the James S. McDonnell Foundation.

confusions, stating and testing tentative hypotheses, and finding new information to resolve outstanding issues.

- The construction of knowledge usually occurs within a social context , therefore a students must learn how to build knowledge collaboratively with others.
- Learning is enhanced when the construction of knowledge is an explicit goal of school activity and not a hoped-for incidental by-product of either teacher-set tasks or student-selected activities.

In a knowledge-building classroom, the teacher is a participant in the ongoing research and a coach, helping the students become expert learners. This dramatically alters the flow of information within the classroom, moving toward the situation depicted in Figure 2.

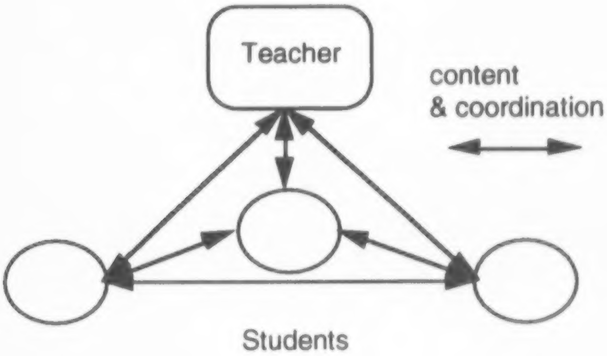


Figure 2.

In this classroom, curriculum content and information about coordination of group activities flows between all participants in the classroom. Any participant or group of participants can dramatically influence the course of classroom work if they have a contribution (idea, question, comment, etc.) that captures the attention of the class.

For a student, knowledge-building is cognitively more stimulating, but more difficult, than sitting while a teacher lectures. For a teacher accustomed to a model of teaching based on content delivery, it is cognitively harder to be a coach to a group of learners (each with their own differences in learning style) than to be responsible for a given body of content. Consequently, while the rewards of a knowledge-building classroom are many and highly motivating, it can be hard to get started. We have found that three elements are required to establish and maintain a knowledge-building classroom:

- a classroom culture which values collaboration and hard questions
- sufficient access to information resources
- an information-sharing infrastructure tailored to support knowledge-building

This paper focuses on the last of these.

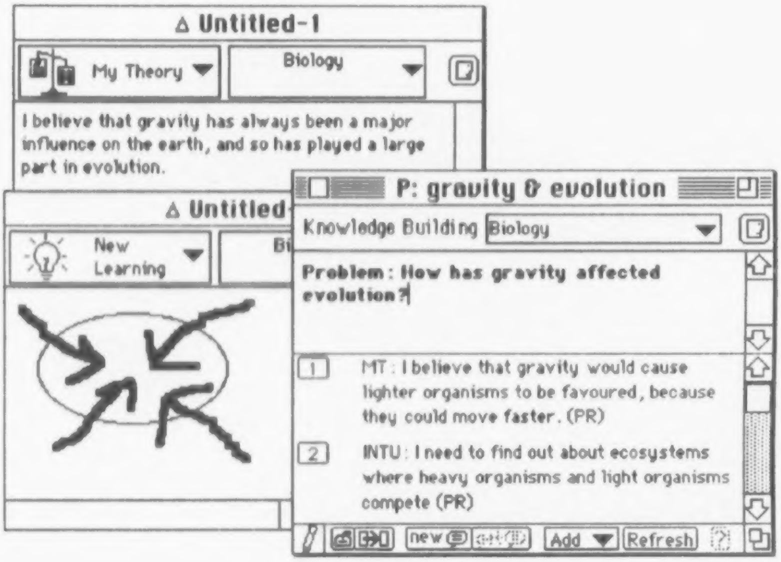
An Information-Sharing Infrastructure for Knowledge-Building

The CSILE System is an example of work in Computer Support for Collaborative Learning. Other examples include Newman's EarthLab (Newman 88), diSessa's Boxer (diSessa 90), and the other systems discussed in this symposium. All systems provide a shared workspace for their users, tailored in specific ways to support particular kinds of collaborative activities.

CSILE's shared workspace allows the information flow of Figure 2 to be practical in a classroom with over 30 students. If paper had to be used instead, the flurry of Post-It™ notes and the expanse of bulletin boards needed to facilitate the required communication would be overwhelming. With CSILE software and one computer[4] for each 3 or 4 students, we have found the model to be entirely manageable.

The system is designed to be as simple as possible, so that it is easy to learn and use, while still providing the necessary supports for a knowledge-building community. We provide a brief account of its core functionality here. The objects in CSILE's shared workspace are called *notes*. Currently, there are three kinds of notes: text, graphics, and discussion. Each has one or more authors, a title, and several attributes (e.g. keywords). All notes can be read by all users, but edited only according to permission rules. ***Labels*** can be embedded within notes and hypermedia-style ***links*** can be created between labels and other notes. A note may be created as a ***comment*** on another note. Authors are notified of comments on their notes.

Students using MacCSILE™, the version for the Apple Macintosh computer, work at computers attached via a local area network to a CSILE server which maintains the shared workspace. They create and save notes into the workspace using the familiar Macintosh File commands New and Save. As others create notes they can, within seconds, view and comment on them.



I believe that gravity has always been a major influence on the earth, and so has played a large part in evolution.

Problem: How has gravity affected evolution?

1 MT: I believe that gravity would cause lighter organisms to be favoured, because they could move faster. (PR)

2 INTU: I need to find out about ecosystems where heavy organisms and light organisms compete (PR)

Figure 3.

Figure 3 shows, clockwise from the top, examples of a text note, a discussion note, and a graphics note. A note's header contains a "thinking type", a curriculum unit tag, and a button to access more information about the note's attributes. Below the note are buttons to create labels and links, to create and retrieve comments, and, for discussion notes, to add to the discussion.

Thinking types are a good example of CSILE's explicit support for knowledge-building. We want students to assume executive control over their learning, i.e. to make conscious decisions about what learning step to take next. An important first step is becoming aware of the role of a particular piece of work. The thinking type tags help students become aware of the nature of their contributions by encouraging them to indicate whether, e.g., they are expressing a theory of theirs (My Theory) or entering, for the benefit of themselves and others, something that they have learned (New Learning). CSILE's asynchronous nature makes such a facility possible, giving it a significant advantage over face-to-face discussions where such reflection is much harder due to the speed of the interaction.

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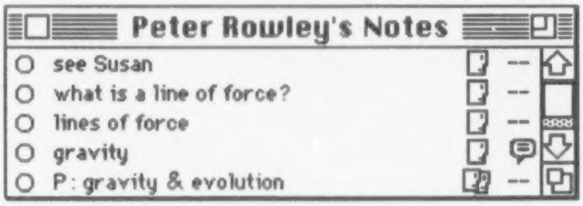
[4] CSILE has been implemented on the Unisys ICON, under BSD UNIX™ with the X Window System, and on the Apple Macintosh computer running System 6 and System 7. The version for the Macintosh, called MacCSILE, is currently the most widely disseminated. Macintosh LC's are used as student workstations along with a Macintosh IIci or faster as a central server.

Thinking types are used in discussion notes (Hewitt 92) to structure the discussion. Each *entry* (marked 1 & 2 in Figure 3) has an *entry thinking type*, used to indicate the kind of contribution. Students follow an expression of their current understanding of a problem (MT - My Theory) with a statement of what they feel they need to clarify or elaborate (INTU - I Need To Understand). Other tags provide support for similar kinds of steps in pursuing an answer to a problem or an explanation of a phenomenon. Much of the CSILE research of the past two years has focused on a variety of extensions to discussion notes, to support laboratory or microworld experimentation and deeper exploration of problems.

Students can retrieve notes on the basis of attribute values, producing a note list (similar to the list view of the Macintosh Finder (Apple 91)) of note titles and information about the note (see Figure 4).


Peter Rowley's Notes

○ see Susan --
○ what is a line of force? --
○ lines of force --
○ gravity
○ P: gravity & evolution --

Figure 4.

Each line corresponds to a note, with a single face representing a singly-authored note, a double face representing a multiply-authored note, and a balloon representing a note that has been commented on. Double-clicking on a note title brings up the corresponding note.

For examples of student work constructed with CSILE, see (Scardamalia 92) and (Scardamalia 93).

CSILE Support For Collaboration: Beyond File Sharing

Many of CSILE's facilities will appear familiar to users of the Macintosh Finder and integrated applications such as ClarisWorks (Claris 93). Yet CSILE offers distinct advantages over use of such applications with a networked file server such as AppleShare 3.0 (Apple 92). The following sections examine those advantages and thereby illuminates how the design of CSCL software can encourage or discourage various kinds of collaborative classroom activities.

Aggregating Knowledge

The Macintosh file system, extended over a network with AppleShare 3.0, supports a hierarchical set of named folders which may be used to cluster documents (see Figure 5).

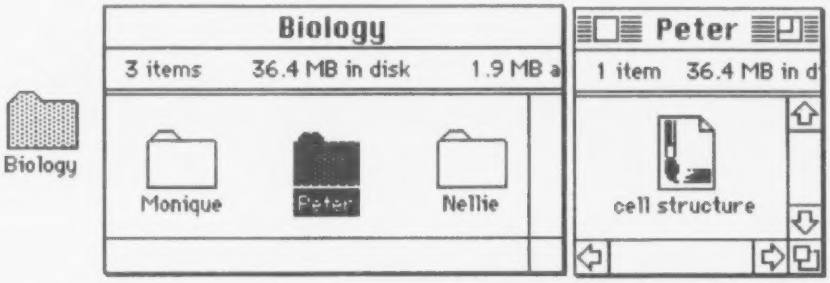


Figure 5.

Different classrooms may construct different arrangements of folders to serve their different needs. Aliases may be used to allow a single document to act as though it is in several folders.

In contrast, MacCSILE supports a single pool of notes, each with a number of attributes. A student retrieves a set of notes with given characteristics for a particular purpose at a particular time. Students are not bound to a static organizing structure for retrieval and the teacher does not have to expend effort setting up a particular structure and further effort maintaining it to adapt to changing classroom interests. Moreover, changing an attribute for a particular note is very straightforward (usually just a pop-up menu choice). Usage data gathered by MacCSILE shows that students use all retrieval options (e.g. author, topic, keyword, thinking type) on various occasions.

Sharing Knowledge

For each folder, Macintosh file sharing defines an owner and a registered user or group (a set of users constructed by a network administrator). Different permissions to see and use the files and folders within the folder can be set for the owner, registered user/group, and everyone else. By default, all files within a folder are private. AppleShare 3.0 administrators can set an option on a folder so that all folders created within it inherit its set of permissions.

In contrast, by default MacCSILE makes all notes viewable by others but only editable by the owner or by a list of users the owner has specified. This promotes sharing and allows the creation of transient groups to be practical, as no action by a central authority is required. Further, MacCSILE can be set so that any user may add to a discussion note or so that only listed users can add to it.

Usage data shows that MacCSILE students create transient groups often. In one class of 32 grade 5/6 students, 48 different authorship groups were created over the course of the school year. The ease with which this is done facilitates classroom collaboration considerably and allows group structures to adapt to changing social structures and patterns of shared interests.

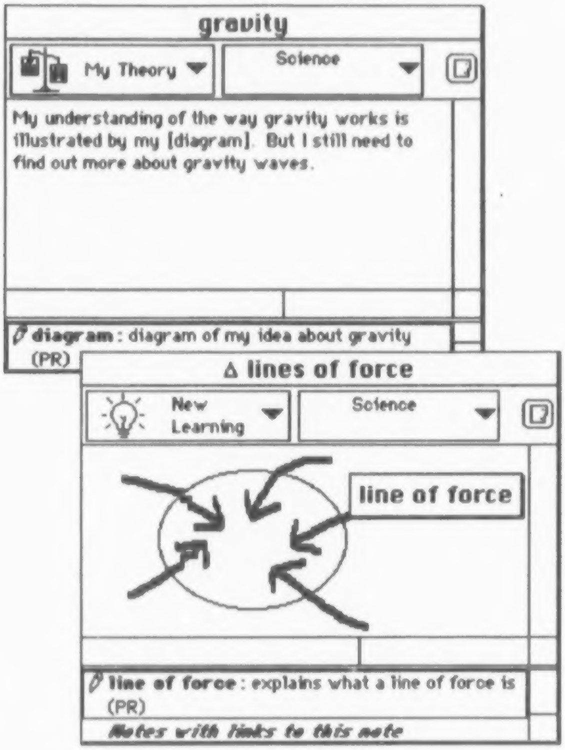
Linking Knowledge

Using the Macintosh System 7's Publish-and-Subscribe facility, a user may construct a document which includes within it all or a portion of another document. If the second document is changed, it is straightforward to obtain a new version of the first document which reflects those changes. In this way, the first document references the second. In order to establish a linkage between a document A and a document B, the author of document B must first publish the relevant section and then the author of document A may subscribe to it.

In contrast, MacCSILE supports separation between the contents of a document and links to other documents so that all users may establish links between any two notes. The destination note of a link does not appear embedded within the source; this allows for more flexible use of screen space.

MacCSILE supports linking with and without content labels. To make a link without content labels, a user specifies the source and destination notes using a simple interface based on drawing a line between the two notes on the screen.

Linking with content labels is illustrated below. The upper note is linked to the lower note via the label [diagram].



My understanding of the way gravity works is illustrated by my [diagram]. But I still need to find out more about gravity waves.

diagram : diagram of my idea about gravity (PR)

line of force : explains what a line of force is (PR)

Notes with links to this note

Figure 6.

Links are listed below note contents with an icon indicating whether the current user may edit the link, the link label, the reason the link was made, and the initials of the user who created the link. If there are links *to* a note, a special "Notes with links to this note" item is available to traverse the links backward.

Students have used this mechanism to depict hierarchies ranging from the structures of plants, eyes, and volcanoes (with labels on parts linked to magnified views of those parts) to task coordination for group projects. It is often used for "see also" references. Over a 5 month period, 27 students in one grade 5/6 CSILE class created 176 links. This would not have been practical with Publish-and-Subscribe.

Integrated Discussions of Knowledge

As discussed above, one of CSILE's note types is ***discussion*** (see Figure 3). Much like a bulletin board conference, discussion notes support a group discussion of a particular problem. However, a discussion note has important advantages relative to a typical BBS conference:

- Each entry has an entry thinking type, encouraging a contributor to reflect on how they are adding to the discussion.
- It is straightforward to create a link from a label in a discussion to supplementary material such as a graphics note that provides a visual look at a point made in the discussion -- or to another discussion.
- The entries of a discussion are juxtaposed rather than presented separately, making it much easier for a contributor to add relevant material to the discussion and for a reader to follow the discussion.
- Entries may be edited after they are added to the discussion, so that contributors may fix spelling and grammar. This increases participation since students know they can recover from mistakes.

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Conclusion

MacCSILE offers several advantages over AppleShare for the support of knowledge-building communities:

- flexible mechanisms for aggregating information that do not require premature commitments to particular hierarchies
- flexible mechanisms for sharing information that support transient groups
- linking mechanisms that support examination of part/whole relationships, deal with the realities of small screens, and allow linking of any two notes by any member of the knowledge community, provided that a justification is given
- support for discussions that have significant reflective components, in terms of the overall goal of the discussion, the roles of each contribution, and the flow of the discussion over time.

We hope that CSILE and other CSCL systems like it will help to bring about changes in classrooms that will result in students being better able to enjoy the excitement of learning and be ready for a working life that will in all likelihood depend on their ability to learn rapidly and deeply and solve problems that others have not encountered before.

Acknowledgments

Thanks go to Marlene Scardamalia and Carl Bereiter, CSILE project directors, for their vision and unwaveringly high expectations of students and schools and to the rest of the CSILE Team for creativity and persistence over many years. Special thanks go to the current members of the system development team, Carol Broderick, Jim Hewitt, Aron Kwok, and Alan Rosenthal, for their good humour and excellent work and to past members of the systems development team who contributed many long hours to CSILE's success: Sheryl Brock, Earl Fogel, Robyn Kozierok, Wayne Liu, Russell Owen, Ed Semeniuk, Jim Thornton, and Tom White.

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The Collaborative Learning Laboratory: A Technology-Enriched Environment to Support Problem-Based Learning

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Key words: CSCL, collaborative learning, problem-based learning

Abstract

The Collaborative Learning Laboratory (CLL) is a technology-enriched environment to support collaborative learning activities. The laboratory provides a reconfigurable environment of hardware and software including multimedia, networking and other computer-based facilities. In this paper we describe a project to augment Problem-Based Learning (PBL) in the CLL. PBL is a collaborative and student-centered method of instruction that has been used extensively in professional education and is currently being introduced into secondary education. We will describe ways in which PBL, and in particular PBL team meetings, can be enhanced through the affordances of the CLL.

Introduction

Changes in education theory have resulted in various reconfigurations of classrooms. In particular, in the field of medical education a widespread dissatisfaction with the traditional methods of education (Gastel & Rogers, 1989; GPEP, 1984) has led to an alternative approach to teaching—Problem-Based Learning (PBL) (Barrows, 1985; Barrows & Tamblyn, 1980). The PBL approach emphasizes collaborative learning as an alternative to the traditional teacher-centered approach. In traditional classrooms teacher lectures and individual student work form the main learning methods. Essentially the emphasis is on teacher-student interaction as the main ingredient to success. Collaborative learning emphasizes student-student interactions as well as students-expert interactions in the learning/teaching process. The students actively participate in the learning process by attempting to solve a problem or investigate an issue as a group, interacting with each other in their deliberation towards a solution of the problem or understanding of the issue. Examples of collaborative learning include cooperative learning (Slavin et al, 1985), project-based instruction (Blumenfeld et al, 1991), and PBL. Although these methods vary in form, they all have in common an emphasis on participant interaction as the key to their success. Given the success of these methods the next question is how to advance them.

The changes in classroom configurations and educational methods give rise to new needs in the classroom. Current technology often offers means of support to meet these needs and improve the efficacy of these new classrooms through information collection, dissemination, and presentation (Koschmann, Myers, Feltovich, & Barrows, in press).

Our paper is concerned with how PBL can be supported and advanced through the use of multimedia and computer technology. Multimedia offers the ability to present information in various and editable formats. Video technology together with computers can present problem data with greater authenticity. Any collaborative environment implies a heavy exchange of information, and success of a collaborative enterprise requires rapid and accurate exchange of this information. Electronic information technology provides various options for rapid collection and distribution of information. Additionally, multimedia technology introduces some new alternatives for information presentation. We intend to show how the already successful PBL method can be supported by multimedia and computer technologies, thereby strengthening and improving its effectiveness.

This paper describes the Collaborative Learning Laboratory (CLL), an experimental platform for the introduction of technology into PBL classrooms. We emphasize that we do not intend to introduce a new way of teaching; instead we plan to support and enhance the already successful PBL classroom.

The paper begins by introducing PBL methods, and describing the traditional practice of PBL. Next the CLL, an experimental platform for technological support for collaborative learning, is presented. The paper then describes how the PBL classroom will work with the technological support afforded by the CLL. Finally, further arguments for technological augmentation of the PBL classroom are presented.

Problem Based Learning

PBL (Barrows, 1985; Barrows & Tamblyn, 1980) was developed to address various shortcomings in traditional approaches to medical education. The reasons for dissatisfaction with traditional approaches to medical education have been described elsewhere (Gastel & Rogers, 1989; GPEP, 1984). Reforms proposed emphasized the need to engage medical students actively in the learning process (as opposed to being passive recipients of knowledge distributed). Instead of lectures, a more interactive approach of instruction that embedded knowledge acquisition and reasoning development within the context of ultimate use, and encouraged development of self directed learning skills (Collins, Brown, & Newman, 1989; Feltovich, Spiro & Coulson, (1989)) was proposed. PBL uses a collaborative learning methodology to encourage this form of engagement on the part of the students.

The PBL classroom comprises a small group (five or six is considered optimal) and a PBL coach. The PBL concept requires students to work through a clinical case (clinical teaching cases are developed for this purpose). Working through a clinical case typically involves interviewing the patient, conducting physical examination(s), requesting and studying laboratory tests, and so forth. The idea is to put the PBL group into the context of a physician working on a patient case.

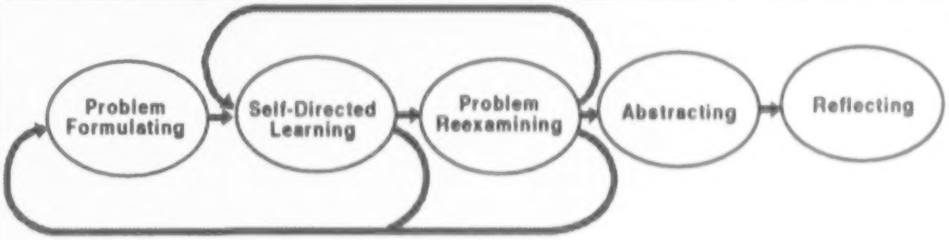

Figure 1: Stages in the Problem-Based Learning Methodology (from Koschmann, et al, in press).

An outline of the PBL method is shown in Figure 1.

At the start, the students are presented with a clinical problem. A variety of methods are used to present the clinical case to the students. The preferred method is to have students interview and examine the actual patient (Barrows, 1985). However, due to practical considerations, this practice is generally not feasible and it becomes necessary to simulate this encounter with the patient. Patient encounters can be simulated using "Standardized Patients"—a standardized-patient is someone trained to act as the patient (Barrows, 1987). A second alternative is to use a Problem-Based Learning Module (PBLM) (Distlehorst & Barrows, 1982)—a textual database simulation of the patient encounter (see section below). Whichever method is used, the students are required to go through the steps of interviewing and conducting a physical examination of the patient.

When human patients (actual or Standardized) are used, the patient may be interviewed individually by each student or as a team. In the first approach, the participants each take turns at the examination process. While a student examines (and interviews) the patient, the rest of the team observes. At the discretion of the coach and according to facilities available, members of the group may be physically present in the examination room or remotely observe the encounter. The students are encouraged to make notes of their observations of their peers' encounters as well as of their own.

The patient encounter is followed by a phase of self-directed learning. The PBL tutorial group (students and coach) meet to carry on further work on the clinical case. The students, relying on information collected so far and other pertinent prior knowledge, attempt to analyze the problem further. Using the PBLM, they may also request laboratory tests. The PBLM may also provide answers to queries (patient directed questions or physical examination) that were erroneously overlooked in the actual patient encounter. During the tutorial meeting, the emphasis is on collaboration and self-directed learning; the students explore the case for data, propose and argue hypotheses, and exchange knowledge. A

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student, appointed as "scribe", is tasked with recording the deliberations of the group. The information gathered is categorized as follows: Data—information discovered about the patient, Ideas—hypotheses proposed about the nature of the clinical problem, Learning Issues—identified knowledge deficiencies within the group with relation to the clinical case, and Actions—proposals for further evaluation of patient or managing the patients condition. The work of the coach is to guide and evaluate this exploration process. Following this episode of self-directed learning, the students are allowed to proceed with individual study to rectify identified individual and group knowledge deficiencies.

Utilizing various resources such as libraries and human expert sources, the students complete their individual study. The group then reconvenes for a continued examination of the problem, applying their newly acquired knowledge to the process. Again, the collaborative process follows the practice of the earlier tutorial session—the continued progress of the group is recorded by the scribe, with the coach guiding and evaluating the process. This two step phase of collaborative exploration and independent study is repeated until every member of the group is satisfied that the problem has been sufficiently explored.

Once the group has successfully explored the problem, they next proceed to examine the case in context of other cases they have seen. This is called the abstraction phase. The idea is to force the students to articulate the knowledge acquired, to make generalizations between cases where possible, to identify connections between lessons learned across cases, and to identify similarities and differences among cases.

Finally in the reflection phase, the group does a self critique of the clinical reasoning process they followed in the case, thus accomplishing an "abstracted replay" (Collins, Brown, & Newman, 1989). The abstraction and reflection stages are intended to make the student aware of the whole problem exploration approach and to identify areas for future improvement.

The Problem-Based Learning Module (PBLM)

The PBLM is a text-based simulation of the patient encounter and laboratory tests. It provides responses to questions that a physician might direct to a patient, observations that a physician may make during a physical examination of the patient, and results of laboratory tests that a physician might request. A PBLM contains a database of responses to all possible queries (questions, physical examinations, laboratory tests) that a physician might make of a particular patient. The PBLM thus provides a complete simulation of a patient encounter as well as pertinent laboratory test results. All data items in the PBLM are indexed in an external reference (i.e., the "PBLM User's Guide"). The PBLM was designed to avoid cueing the student as to the appropriate questions to ask.

The Traditional PBL classroom

In the traditional PBL meeting, two students are appointed to serve the role of "scribe" and a "narrator". As described above, the scribe records the groups deliberations on the board. In the process of exploring the case, student queries may require reference to the PBLM. The job of the narrator is to read data items from the PBLM to the group. The job of the coach is to guide the exploration process and ensure that haphazard guessing and arbitrary reference to the PBLM does not take place.

At this time, it is important to note the information exchange and presentation that occurs in a PBL classroom. Students take notes of the team's progress as recorded on the board as well as their own private notes for subsequent use. Following an episode of individual study, students exchange new information individually discovered. Typically information is disseminated in the form of photocopies and resource (e.g., texts, journals) references.

Information presentation takes various forms. The patient itself may be human or simulated by the PBLM. Most information presented by the PBLM is textual, but may include pictorial and graphic information, and laboratory type media such as X-rays, tissue samples, etc. To enable laboratory type presentations, the PBL classroom may include light boxes for X-ray examination, and microscopes for the examination of tissue slides.

The Collaborative Learning Laboratory

The Collaborative Learning Laboratory (CLL) (Koschmann, et al, in press) is an experimental platform for research into electronically-supported collaborative instruction. The Laboratory is intended to augment collaborative learning practices, through technological support using various hardware and software tools. The CLL achieves this by providing hypertext/hypermedia (Conklin, 1987) facilities, groupware (Stefik & Brown, 1989) and database facilities, LAN technologies, and Internet links. In this section we focus on a CLL learning laboratory configuration tuned to augment PBL.

The CLL is comprised of a set of Macintosh workstations linked by a LAN. A router provides Internet access for all computers in the LAN. A video circuit links each computer's monitor output into a selector switching device connected to an overhead public display projector. Other sources of composite video output (e.g., video disc, remote video cameras, video conferencing equipment) can also be patched into the switch box. This allows the output of any computer screen or other video source to be projected onto the overhead public display.

Three elements of the CLL play a crucial role in the augmentation of the PBL classroom and require lengthier discussion. They are: e-talk—an electronically supported conversation (ESC) facility (Koschmann, 1993), the Teaching Case Library; and the Clinical-Encounter Simulation Stack—a hypermedia database substitute for the PBLM.

E-Talk The Electronic Collaboration Support Element

E-talk (Koschmann, 1993) was developed as an experimental platform for investigating the affordances of electronically-supported conversation (ESC) in classroom instruction. Conceptually, e-talk is similar to the talk utility in UNIX; it provides added functionality including the provision for remote conferencing. It provides users with the ability to carry out typed conversations over a computer network in real-time. Text typed on one workstation is instantly displayed on the other participants' screens. Typically each user has two windows: a window in which to type messages (termed a dispatch window) and a window in which received messages are displayed (termed a listener window).

E-talk allows dispatches to be sent to multiple recipients. Thus a conversation can include more than two people. Further, a user can be involved in multiple independent conversations, as though they had an array of phones over which to converse. Each dispatch window is linked to a specific listener or set of listener windows. Both listener and dispatch windows offer simple word-processing functionality. Text typed into a dispatch window is transmitted to designated recipients through a dispatch command. Messages received by a Listener window are appended to the bottom of the current text in the window, providing a reviewable and editable transcript of the conversation. Every message includes a time-stamp and address (user defined name) of the dispatch window in which it originated.

Unlike the UNIX talk utility, e-talk opens listener windows and dispatch windows independently of each other. Whenever a listener window is opened, it is recorded in a central registry using a unique user defined name. When a dispatch window, is opened the user is prompted to select a listener (or listeners) from a menu of known listener windows. The user can have several dispatch channels open simultaneously by opening multiple dispatch windows each addressing different sets of recipients—each channel representing a separate private conversation/conference. Similarly, the user can open multiple listener windows, each receiving dispatches from different users. Note that since a listener window is addressable by more than one user, it allows a many-to-one functionality. Finally, a dispatch windows can be defined to be "broadcast" windows—permitting them to broadcasts to all known listener windows (except those explicitly prohibiting reception of broadcast-type messages).

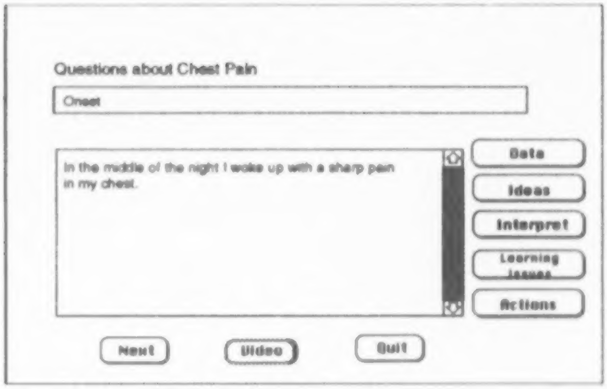
Using the functionality provided, various participation configurations are possible. Users can participate in multiple independent conversations/conferences. Users can participate exclusively as listeners, exclusively as speakers, or as both speakers and listeners in a particular conversation.

The Teaching Case Library

The Teaching Case Library (TCL) is a repository of case data drawn from actual clinical cases. For each clinical case (patient encounter) the data includes responses to all possible interview queries, physical examination probes, and laboratory tests. The database is maintained as an integrated relational database of all prepared clinical teaching cases. Using relational database techniques, a single clinical case (PBLM) can be extracted into a separate independent database. This facility allows individual clinical cases to be extracted and incorporated into a variety of presentation formats, including the conventional PBLM textual format or into computer-based, hypermedia formats.

The Clinical-Encounter Simulation Stack

The Clinical-Encounter Simulation Stack (CESS) is a *HyperCard*-based, multimedia database providing the same functionality as the PBLM. CESSs can be generated automatically using data extracted from the TCL.



Questions about Chest Pain

Onset

In the middle of the night I woke up with a sharp pain in my chest.

Figure 2. Shows an example of a user screen from the CESS

The user identifies the type of query to be made: Interview, Examination or Laboratory Test. The user then types in query or request for information. CESS responses may be in text or other media. For example, laboratory data such as an X-ray copy may be displayed using a computer bit map, video (VCR) or an actual X-ray photograph; a patient's heart beat may be presented audibly. Similarly, a patient's response to an interview question or an exam item may be presented in video form, with particular queries indexed directly to relevant segments of video. Thus a data record may be a segment of text, a segment of video, an audio segment, a computer graphic, a video frame, or an X-ray photograph. The multimedia environment offers multiple options for presenting case-related data. Special media and computer-interfaceable devices are used to present audio and video data. Appropriate device commands and medium indices are incorporated into the Teaching Case Library (and the extracted CESS).

The CLL Augmented PBL Classroom

We now look at how the PBL classroom works with the facilities afforded by CLL. The CLL and its associated software is designed to allow PBL participants (both students and faculty) great flexibility in adapting its resources to meet the needs of the group. Great care was taken to ensure that the introduced technologies do not interfere with the valued discussions that occur in PBL meetings.

The Configuration of the Classroom

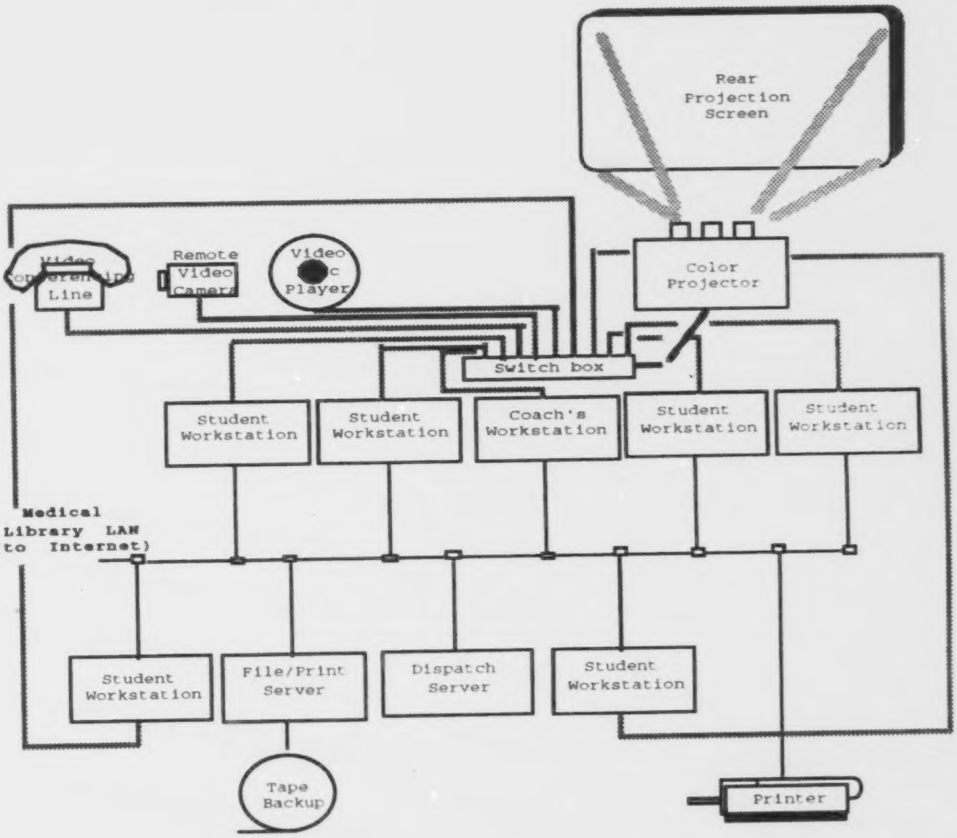

Rear Projection Screen
Video Conferencing Line
Remote Video Camera
Video Disc Player
Color Projector
Switch box
Student Workstation
Student Workstation
Coach's Workstation
Student Workstation
Student Workstation
Medical Library LAN (to Internet)
Student Workstation
File/Print Server
Dispatch Server
Student Workstation
Tape Backup
Printer

Figure 3.

As shown in Figure 3, every student in the CLL is provided with a workstation running e-talk. Students also run other applications locally (e.g.. word processors, graphic software).

E-Talk set-up

The following is a description of an e-talk configuration for the PBL classroom. At the discretion of the coach, other configurations may be implemented. A multiway simplex channel is set up between the scribe and every other member of the team . This allows the scribe to distribute copies of the shared information which he/she maintains. In addition, we have

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experimented with a multiway full duplex channel between the coach and every student. This allows the coach to conduct private conversations with students in an otherwise open forum. Members of the team are also allowed to implement their own private channels, allowing other private conferencing and conversations to occur.

The Narrator

In the PBL classroom, the narrator is responsible for referencing the PBLM and narrating the information found to the team. In the CLL, the CESS is currently loaded into the narrator's workstation. The narrator's workstation is also wired to control other media devices, such as video and audio devices. Responses from the CESS are then displayed at the narrator's monitor and from there projected to the public screen.

The Scribe

In order to maintain the team's shared information the scribe is provided with software that allows him to open a four-paned editable window on the workstation. The four panes are independently scrollable and are use to maintain the four categories of shared information: Data, Ideas, Learning Issues and Actions. The scribe's computer desktop, like that of the narrator's, can be projected on the public screen. The information compiled by the scribe is maintained as a reviewable record of the team's deliberations.

A PBL Tutorial Session

The PBL session proceeds in the fashion outlined in Section 2 with minor modifications. The scribe maintains the team's shared information on what is conceptually an electronic blackboard. The PBLM is available as a computer-controlled, hypermedia database. Information can be exchanged electronically using e-talk. While the process of examining the clinical case remains as outlined in Section 2, it is necessary to examine the innovations allowed by the introduction of technology.

Information Collection and Distribution

Students use text and graphic editors on their workstations to make private notes. Since most information is maintained electronically, the dissemination of information is facilitated using e-talk. Further, if members are required to post their contributions to the team's shared information window (currently maintained by scribe), they will be forced to better articulate their ideas (Koschmann, et al., in press). During individual study, information gathered electronically from sources such as scanners, on-line medical library facilities, and E-mail , can be easily presented and disseminated to the rest of the group using e-talk.

The ability to access geographically-remote information can also be carried out in the classroom. Since e-talk allows channels to be set up across the Internet, it is possible to set up an electronic conference with remote consultants. Besides conferencing, remote databases and libraries can be accessed directly from the classroom. The team can compose and send E-mail (presumably to query remote experts) as well as receive E-mail replies during tutorial sessions.

An important aspect of information handling in the CLL is that a permanent and editable copy of all information can be easily maintained. In contrast with the traditional use of blackboards and notebooks, this ability to maintain a retrievable record of the groups deliberations constitutes and important feature of working in the CLL.

Private Channels in an Open Forum

The ability to establish person-to-person e-talk channels allows participants to carry on private conferences in an otherwise open forum, a feature we have termed "a private channel in a public forum" (Koschmann, et al, in press). For example, the coach can make use of this facility to poll each student independently. This forces members to contribute opinions and reduces domination of the process by only some members. This facility also allows the coach to evaluate individual students.

Archiving

The electronic information support by CLL allows students to archive every clinical case they encounter. This archive not only includes the case data but the entire analysis process followed by the team as recorded by the shared information resource maintained by the scribe, the students private notes, and other information collected during the PBL process for the case. This archive can be subsequently indexed at the students discretion, and used in the Analysis phase of PBL for other cases.

Building PBLMs and the Teaching Case Library

Creating a PBLM is a non-trivial task involving gathering all pertinent information regarding the case (interviews, examinations, tests etc.). This information must then be carefully examined, partitioned and indexed to provide a database that can be queried productively during case analysis. Designers need to ensure that only relevant information is revealed in response to a query; also responses should not provide cues to students as to follow-up queries. There is a need to ensure that responses are entered for all possible questions. With the traditional text-based module using question categories to index into the module, there is a necessity to elaborate on responses to questions so as to limit the need for follow-up questions and ultimately on the size of the module.

The use of an a computer database (TCL) has all the advantages of electronic text handling. Using keyword identification techniques reduces the cueing problem of traditional modules. Employing a relational computer database reduces the problem of including individual responses to every question; since the module (CESS) used for a particular case is dynamically generated from the TCL. The integrated database allows common information to be shared across cases, and building a new module is facilitated by information already present in the library.

Updating the Teaching Case Library

The traditional method implements a PBLM as a text book. Non-trivial update of such a module invites all the problems of updating any paper-based text resource. Relational databases on the other hand are easily updated to correct errors or include supplemental information.

Discussion

We are currently in the process of evaluating the CLL and its effects on process in the PBL meeting. The introduction of technologies such as those described in this paper may effect these meetings in subtle and, as yet, not well understood ways. Furthermore, the effects are not stable in that as the participants become more accustomed to introduced technologies, they may come to use them in new ways, including some which may not have been anticipated by the developers.

Therefore, to help us understand what these innovations mean to the PBL participants, we are undertaking a number of observational studies of PBL meetings—both augmented and unaugmented by technology. In an earlier paper (Koschmann, et al., in press), we attempted to articulate what constituted exemplary performance in a PBL meeting. This we presented in the form of six principles. Using ethnographic methods, we are now investigating to what degree these principles are honored in practice. Through this approach we hope to eventually answer the central question which is: how is the character of a PBL meeting changed when conducted in the CLL?

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Paper (T2-202A)

Formative Evaluation of a First-grade Multimedia Forest Environment

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Key words: multimedia, elementary school, science education

Abstract

An evaluation of a CD-ROM based multimedia component of a first grade science curriculum is presented. Results indicated that children could use the technology, and work together as a group without teacher assistance. However, the children were also unable to execute the specific tasks they were assigned, due to weaknesses in the design of the multimedia content. Changes that should improve this technology are described.

Introduction

The advent of relatively inexpensive multimedia platforms has produced a conceptual and practical quandary for educators. Multimedia seems to have dramatic educational potential, but how exactly is it to be used? It has become abundantly clear that technology has advanced faster than our understanding of how best to employ it for pedagogical purposes. Given the almost limitless possibilites for the design of such systems, what are the most effective ways to use these technologies to enhance learning in schools? What is the place of such technologies in the classroom's overall organization? The present paper reports the results of an evaluation of one possible model for incorporating multimedia into a new first grade science curriculum.

Curriculum overview

Before describing the multimedia system and the issues assessed in the study, the curriculum for which it was designed should be briefly reviewed. The IBM/CTW "Through The Woods" science curriculum was developed based on several of the life sciences goals laid out in the California Public Schools Science Framework (1990). It focuses on forest life as representative examples of living things. The material is organized into one-week units, each week having its own theme. Three themes were tested in the present study: (1) Living things are composed of smaller structures or body parts; (2) Living things move in different ways; and (3) all living things need food and shelter to survive and thrive.

The curriculum calls for the classroom to be organized as a set of four stations, each serving a different learning objective: A hands-on station, where children examine live animals and study their behavior; a library station, where children read about animals and record their observations; a courseware station, where children manipulate detailed images of animals and examine animations of their movement and other behavior; and the multimedia station, where children go on a self-guided "nature walk" in a virtual forest and collect observations on actual animals engaged in different behaviors related to the curricular themes.

The multimedia station was designed to serve several purposes. Broadly, the multimedia was meant to provide children with a sense of discovery and exploration, and encourage them to test their ideas of where animals might be found, and to observe what animals do to survive in the forest. More concretely, each week children had a different "mission" to find specific things in the forest related to that week's theme. For example, for the week of the movement theme, children's objective was to explore the forest and find animals moving in different ways.

Functionality of the multimedia

The multimedia station was a CD-ROM based interactive video system running on an IBM OS/2 platform. The design metaphor for this station was an investigative walk in the forest. There were no menus or other of the standard computer interfaces in the multimedia. Instead, video filmed from the point of view of an individual walking along trails in the Smoky Mountain National Forest served as a three-dimensional "menu," that gave the impression the user was actually walking in the forest itself. Use of the multimedia consisted of children "walking" along the trails, searching for locations where they thought animals might be found. These trails amounted to a total of 12-15 minutes of "walking," if the users did not ever stop along the trail to search for animals.

Movement on the trail was controlled by a mouse. Icons allowed users to walk forward, stop, back up, or use a map to "jump" directly to one of 12 possible landmarks along the two trails and then walk from there. At any point users could elect to stop on the trail and point the cursor at places where they thought animals might be found (in trees, under rocks, behind bushes, etc.). In some places along the trail animal sounds played (birds chirping, toads croaking, etc.), as a cue that something could be found nearby.

Highlighting of screen locations when touched by the cursor indicated that a living thing was indeed present. If the location was clicked on, the users were presented with one of three results: (1) A brief, full motion video segment with audio, showing an animal; (2) a high resolution still image of an animal, without audio; (3) a high resolution close-up view of the location clicked on. The close-up view of the selected location contained several videos and stills of animals, and users could find the animals in the still in the same way they found the 'hiding place' on the main trail: Moving the cursor to different places and watching for a highlight.

The videos all showed animals performing specific behaviors, related to the content goals of the curriculum, with ambient audio (birds would chirp, water could be heard if an animal was swimming, etc.). Each video was accompanied by a spoken audio description that included the animal name and information about the animal, tailored to the specific curricular themes. The audio could be heard by clicking on a separate icon accompanying the video.

Every visit to the forest began in a "ranger station" where the children clicked on a mission icon to learn what they were to look for on this particular walk. This was the only statement of their task that they received during the session, unless they replayed the mission statement voluntarily while using the system. The mission icon played a spoken set of instructions without accompanying graphics of any kind (See Table 1 for the text of each week's mission). Children then began their search, finding and recording animals whose behavior or location related to the weekly theme. Children recorded their findings in two ways. First, there was an "online clipboard," which allowed the users to save up to four videos for later examination.

Week	Mission Statement
1 (Parts)	On this walk, find four animals whose body parts have something interesting or special about them. Put each one on your clipboard so you can compare them when you're done. (You might want to compare their eyes, or months, or legs.) You can circle the pictures on your worksheet to show what body parts you see on the animals you chose.
2 (Movement)	On this walk, find four good examples that show how animals can move. Put each one on your clipboard so you can compare them when you're done. You can circle the pictures on your worksheet to show what ways the animal you chose can move.
3 (Needs)	On this walk, find four animals that are looking for food, water, or a safe place to be. Put each one on your clipboard so you can compare them when you're done. You can circle the pictures on your worksheet to show what the animals you chose are eating or where you found them.

Table 1. Mission statements children received in the multimedia.

In addition to the online clipboard, each child was provided with his or her own real clipboard, and forms containing checklists appropriate to that day's particular mission and the weekly theme. The forms resembled the online clipboard. The child's task was to record each animal's name, and then fill out the checklist of observations about the animal.

Multimedia usage scenario

The multimedia station was designed to be used by up to four children at a time, for a period of approximately 20 minutes. The children were asked to share the multimedia, and they did this by taking turns "driving" with the mouse. The children were expected to use the multimedia without adult assistance. The rest of the class was engaged with the other three stations while the multimedia was being used.

Goals of the evaluation

The evaluation of the multimedia station's performance in the context of the Through The Woods (TW) curriculum focused on four areas.

The interface and design metaphor

The TW interface is based on a point-of-view navigational system, controlled by icons. Can young children use such an interface? Do children understand the metaphor of the nature walk, and what they are to do in their visit to the virtual forest?

Use of the video and audio information

The content of the multimedia is delivered exclusively through motion video, still images, and spoken audio. The multimedia's stated purpose is to allow children to discover the information it contains as they are walking through the forest. Are young children able to process this information and record it, in keeping with the curricular goals?

Effectiveness of the usage scenario

The multimedia station is meant to foster independent discovery and exploration by groups of children. Are young children able to work together in small groups, taking turns using the multimedia and recording their discoveries, without adult supervision?

Mission execution

The content of the multimedia is coordinated with the weekly themes via the specific weekly missions. The missions are delivered to the children by the teachers (announced at the beginning of each class) and by multimedia itself. Are children able to comprehend and execute these missions without the active assistance of a teacher or other adult?

Method

Sample and sites

95 children from four classrooms participated in the present study. Two classrooms were in New Jersey; two were located in Florida. Boys and girls were approximately equally represented. Each classroom was provided with all the materials needed for the curriculum.

The children were organized into groups. Each group visited each station once during the week. During the course of the study, each child visited the multimedia station as part of a group once a week for three weeks, for a total of three experiences.

Procedure

Data was collected from several sources. First, the forms children used during each visit were collected and examined. Second, children were either videotaped or observed with a standardized protocol while using the multimedia. Finally, post-use interviews were conducted with children to ascertain their own notion of what they were doing, and why.

Results

Interface and design metaphor

The children demonstrated no problems comprehending the interface. They easily and confidently used the mouse and icons to direct their travel, select animal hiding places, and store video clips in the online clipboard. The children also grasped the metaphor of the nature walk. Their sensations of travel along the forest trails were very vivid: Children were observed ducking to avoid tree branches on the screen, or warning the 'driver' when they thought they might fall into water or otherwise go off the trail. In addition, when wading through water in one segment of the trail that crosses a stream, children often laughed and said "Our feet are wet! Oh, no!" or made other comments suggesting they easily identified themselves with the point of view being displayed during their travel on the trails.

Most striking, the interface and the computer itself appeared to be completely transparent to the children. When describing their use of the multimedia, the children used language related almost exclusively to the content of the activity: "I looked under a rock and I found some ants!", "I heard a bird in the tree and I found it—it was an owl!", etc. Listening to their descriptions, it was impossible to tell that they had not actually gone to a forest and performed the activity they were describing.

Audio and video content

The children responded to the full-motion video segments with high levels of affect. Images of insects elicited vivid reactions of disgust, for example. Images of baby animals elicited cooing and exclamations of affection. And images of snakes, or large predators (bears) elicited fear reactions (children hiding their eyes, gasping, etc.). Still images, however, were universally derided by the children. Even though the images were quite colorful, the children would ignore them in favor of the motion video segments.

One unexpected finding was that the children showed an aversion to re-examining previously discovered videos of animals. "We found that one already!" was a common comment by the children when the an animal discovered on an earlier visit was discovered again. Even when the rediscovered video or audio content was directly related to that week's mission, children would not record it. They showed a persistent preference for finding new animals (see mission performance results, below).

The audio produced mixed results. The animal sounds heard along the trails, or as part of the videos, were especially compelling to the children. They would imitate sounds, and in the case of hidden animals they would guess what produced it, and always searched diligently to locate the animal. The spoken information accompanying each animal, however, was often ignored. Children would talk over it, not play it at all, or simply exit the video while the audio was still playing.

Usage scenario

The children's performance as a group was remarkably free of rancor or competition. Whatever method of sharing mouse control was used, the group worked together searching for animals quite well. Children who were not 'driving' constantly made suggestions about where to search for animals, and the 'drivers' heeded these suggestions in a majority of cases. In addition, the print forms provided for each child to record the animals found by that group functioned very well as an activity for the nondrivers. When animals were found, the nondrivers would confer with one another about what to record, or how to spell animal names, as they filled in the forms.

Mission performance

While the interface, group dynamics, etc. worked well, the children were unable to execute the specific missions assigned each week. They tended to listen to the mission statement, but uncomprehendingly. Instead of examining the images of animals in relation to the mission criteria, children simply created their own "mission," which was always the same: To search for as many different animals as possible.

In a similar vein, children's recording of their "findings" was deficient. The use of the online clipboard was spontaneous and idiosyncratic, rather than task-related. Children saved images in the clipboard because they "liked" them, or because the image was unusual. They used their real clipboards in a similar manner. Examining their written work later, it was difficult to tell which animals the group had seen because they failed to record this information accurately or consistently.

Conclusions

The multimedia station clearly succeeded in its broad goals of fostering independent discovery, and of stimulating children to explore the forest and test their ideas about where animals might be found. Children found the "nature walk" metaphor highly engaging, and the interface design was so natural as to be transparent to the children in their experience of the system. The use of motion video and audio in the form of animal sounds likewise was very effective in conveying a vivid sense of actually exploring a forest environment. The usage scenario also appears to be viable for children at this age. The children in the study took turns using the mouse in an orderly fashion, without adult supervision. Children controlling the technology also listened and responded to the suggestions of their fellow students when searching for animals, fostering a sense of collective effort.

The weaknesses of the multimedia's design were in the way it used spoken audio, both to present information and to support mission execution. Both the spoken audio information accompanying the videos and the content of the mission were apparently too long, and contained vocabulary too abstract, for children to process and understand. The mission statements did not explain to children what they were to do in a sufficiently specific, concrete way. This finding reflects the results of previous work on preschoolers and spoken audio (Strommen, 1991), and suggests that the same standards for audio appropriate for that age (brevity, concreteness, directed action, etc.) are appropriate for first grade children as well.

Even if the missions were more clearly stated, the children's strong tendency to invent their own "mission" suggests that there is a need to periodically reinforce the actual mission while children use the multimedia, so they can stay on task. There were no audio or other cues built into the system to remind children of the goal of the mission they were to be executing; once they had listened to the mission statement at the beginning of their session with the multimedia, they were never prompted about what they were doing or why. Adding prompts at key interactions during use could be very effective. The prompts could be designed to play when children select animals ("What body parts does this animal have?"), or when they are saving animals to their online clipboard ("Does that animal show a special body part??"). Including such "reminders" may be critical if there is to be no adult supervision to assist children in staying on task.

In closing, the present results indicate that multimedia technology can be a viable component of the particular classroom and curricular context tested in the present study. Groups of children can use the technology independent of adult guidance, and they can execute the general task (searching for animals in a simulated nature walk) that it was designed to support. However, the technology's open-ended quality also turned out to be something of a weakness. The specific content of each nature walk, which relates to the content goals of the curriculum itself, was apparently not effectively delivered to the children. Changes in the design of the multimedia to enhance on-task performance are necessary. Such changes should improve children's use of the multimedia, and improve its pedagogical impact as part of the science curriculum for which it was designed.

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Project (T2-203A)

Look at Me, I'm Special

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Key words: special education, whole language, multimedia, middle school, speech and language

Abstract

"Seeing is believing" and "A picture is worth a thousand words" are sayings my special education students at MS (Middle School) 88 may express when they use the computer, video and VCR to learn speech and language.

The student population is comprised of learning disabled, neurologically impaired, physically handicapped and emotionally disturbed. My caseload is about 56 students.

When learning language skills, special students experience more apprehension, anxiety and feelings of insecurity than the average student. Therefore, our approach must include more patience and an attempt to create an environment that encourages active participation while we remain aware of their psychological and emotional needs. We achieve this goal by using "whole language".

The object of the project is to develop survival skills necessary for everyday living, such as getting dressed for school, using the telephone and shopping for food. Auditory and visual memory, auditory and visual recognition, and sequencing are the language skills we want to develop.

Word processing becomes part of the planning and organization of our project as well as students corresponding with penpals in Japan and China.

The students learn how to operate the video recorder. One group videotapes while the other group is being recorded. The end result: we have a videotape to watch on the VCR for peer and self evaluation.

The lessons are fun and natural which allows for the development of self esteem. That is why my students can say, "Look at Me, I'm Special".

Project (T2-204B)

The Environment as Catalyst for Technology and Curriculum Integration

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Key words: integration, environment, video, sinkholes, Macintosh, legislature

Abstract

What can contaminate your drinking water, send water streaming throughout your house, and lead to the formation of huge systems of caves? Students at Woodbridge Academy, a small private K-12 school in Midway Kentucky know the answer is Sinkholes. With the support of a grant through Apple Computer's Crossroads 3 program and followed up by an Educational Leadership Award, Richard Goldsworthy and John Gagel, Woodbridge Academy's Technology and Science Coordinators and teachers, with the help of the rest of the Woodbridge staff, have implemented The Sinkhole Project.

"Sinking" into the Environment

In *The Sinkhole Project*, students of all ages have been studying this environmental phenomenon in which subsurface limestone is eroded away to form underground streams and caves as well as bowl-like depressions in the earth—the sinkhole itself. Sinkholes are very prevalent in Kentucky because of the great expanses of underground limestone deposits left behind when this area was once an inland sea. As the the students are quick to point out, they have discovered pollution of the sinkholes can be a major problem. If a farmer dumps garbage into a sinkhole on his land, the underground stream that created the sinkhole becomes contaminated and from there the pollution can spread to nearby rivers and lakes, perhaps entering the water supply of hundreds of thousands of people. Or what if someone throws a refrigerator or other large appliances into a sinkhole? This may sound crazy but the Woodbridge students have even found an old rusted out car in a sinkhole! Well, if all this solid garbage accumulates in a sinkhole it can seal off the underground stream, acting just like a dam does on an above ground lake or river; however, a obstructed sinkhole is more like a clogged hose than a dammed river. Since the sinkhole stream is underground, it cannot simply overflow the dam. Instead, the stream backs up and builds pressure along its entire path until something gives. This "something" has occasionally been the foundation of a house. Imagine your surprise when you return to your house to find water gushing out the second floor window! The Woodbridge kids have also become spelunkers as they visit caves and cave systems, such as Mammoth Caves—one of the largest cave systems in the country, which began life as tiny sinkholes thousands of years ago and have grown into the huge caverns they are today.

During the course of the Woodbridge Team's Sinkhole adventure, the various strands of the curricula have been integrated around an environmental theme with sinkhole creation and pollution being the focus. Students have learned to analyze soil and water samples, perform quadrat analysis, survey the flora and fauna of an area, and determine the overall level of pollution present at a site. While students are doing all this, their teachers are tying the team's *sinkhole experience* with traditional lessons and information. During the processing of water obtained from a sinkhole site, for example, the students also investigate the nature of the chemicals in the water and the elements of which they are made. "Going on the trips to the sinkholes is really great," said one of our eighth graders, "and its really cool to be able to check out what's in the water… All the chemicals and other junk people throw in there. I couldn't believe it!" After being asked what he thought about *The Sinkhole Project*, another Woodbridge student, Ben Rumer, a tenth grader claimed "Everything has changed since two years ago. I really like having the computers…they make writing a lot easier for me. The spell checker has really helped me a lot." The Macintosh computers have become heart to the Woodbridge staff's soul as they permeate the student's educational experience. The computers have been used for everything from writing and re-writing and re-writing reports to 3D modeling of chemical molecules found in the sinkhole water analyses. One of the Woodbridge students went so far as to say he always hated to write but on the Macs writing was fun! The computers have torn down traditional barriers between classes as students and teachers share information from all their classes. Reports are no longer always pen on paper, or even toner on paper, they have become multimedia presentations using *HyperCard* to bring together many different aspects into a student report—sound and graphics are really "fresh" and the students who have learned to use video have gotten rave reviews from their peers. Not only are reports multimedial but they have become cross-curricular as students, with and without facilitator guidance, have chosen to mix assignments from various classes into one in-depth report. Life isn't segmented into "content areas" why should a student's report be?

In addition to allowing students to learn through multiple medias, Mr. Goldsworthy sees the students becoming more responsible for and active in their own education as the focus shifts from the students absorbing what the teacher has to say to the students being guided by their instructors toward areas of interest. "Our teachers are relying less and less on the traditional lecture/test method of teaching and more and more on facilitating a student's quest for information about a topic. We're not perfect, we all—kids and teachers alike—have made mistakes, but mistakes are part of the learning process and have helped us all grow. I believe mistakes are good. If people aren't making mistakes, then they probably aren't taking chances. The only bad thing about a mistake is not seeking to correct it." Without the computers, he continues, "most of what we have done would have been impossible or at least much more difficult than it has been. The [Macs] have really helped everyone at Woodbridge be successful."

The Woodbridge team continuing its investigation sinkhole contamination this year, and they are preparing to do something about it. During this, the second year of the project, the students have been learning about citizenship and environmental legislation and politics as they followed real cases where people have been prosecuted for environmental crimes in Kentucky. The Woodbridge students have also been developing their own legislation to protect sinkholes which they hope to have enacted. Groups of students are using the technology along with the video editing services of an area manufacturing company to create public service announcements concerning sinkholes, and they will be traveling to other area schools to help other students and teachers learn about sinkholes, pollution, and the environment. What makes this an especially exciting project is that many of the Woodbridge students have a learning disability, some Dyslexic, others ADHD. Most come from schools where they were unsuccessful with the materials taught in the traditional textbook manner. According to the Woodbridge staff, all of the students are gifted, they only need the right environment in order to succeed, and the environment is what our curriculum is all about. Other schools looking toward curriculum integration would do well to consider the environment as their catalyst. As a subject, it offers inlets for all the major curricula strands and it is of immediate and tangible interests to students of all ages and ability levels.

Background

Woodbridge Academy is a state-accredited, not-for-profit school serving the needs of youngsters ranging throughout the K-12 grade levels. The Academy serves a geographically and culturally diverse region known as Central Kentucky which includes Lexington and its surrounding counties as well as a portion of Appalachia. Our student body consists of children who have been unsuccessful or unsatisfied with the traditional school environment. From a variety of different backgrounds and abilities, our students share the characteristic of being learning disabled in one form or another; dyslexia, gifted LD, or attention deficit disorder are a few of the specific learning disabilities which at times plague these children. Many simply are gifted yet unmotivated. Because of their learning differences, many of our students are turned off by traditional textbook and lecture pedagogy. In response, we have found that by incorporating a child's strengths and interests into a direct, *hands on*, multi-sensory learning experience, the student becomes an *active participant* in his or her education and most often attain success.

Our state has a severe sinkhole problem; contamination of sinkholes is very important because ultimately this environmental pollution affects the water supply of hundreds of thousands of people. In our project, teams of students—SINK teams—conduct background research, visit community and government agencies concerned with sinkholes, and collect and analyze water runoff and soil samples from various sinkhole sites in Central Kentucky (In addition to our home base for the project, we have involved several other schools in the Sinkhole research. One such school, Northside Elementary, also in Midway, will be collecting data next year and returning it to us as well as involving us in their own projects. Some of our students will be acting as mentors or facilitators for the younger Northside students to help guide them in their studies—this will be great for both schools as our students' self-confidence and self-image is improved through helping others. Self-worth naturally will rise as students find they can teach too. The thrill of teaching can be addictive.). Our SINK teams are using computers to access, organize, and share information; design experiments, analyze data, and model environmental processes and effects; and draw conclusions, prepare reports, and produce multi-media presentations of their findings. The Sinkhole Project is also unusual because it involves children at all age levels in the school and crosses through the traditional areas of study—reading, writing, mathematics, and civic education—as well as encompassing new and vitally important disciplines such as technology applications and the environment.

Internet Room (T2-206A)

The Scholastic Network and a Live Debate Between Middle School Students

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Key words: telecommunications, debate, middle school

Abstract

The medium of telecommunications as an educational tool has grown tremendously. Use of resources ranging from the Internet to local BBSU, to subscriber services, have provided schools with the opportunity for research as well as sharing electronic mail around the globe and across the hall. The Scholastic Network has recently provided teachers with a place of their own on a national basis. Within this subscriber service are bulletin boards, project areas, reference and news resources, and the ability of teachers to locate other educators with similar interests and classroom goals. In this presentation I will use two groups of middle school students, one at the site, and another group elsewhere in the country. These two groups of students will be involved in a live debate on a timely topic of current interest. The presentation will demonstrate a) how teachers can link themselves via common interests through telecommunications resources; b) how this connection provides a medium for discussion and planning of interactive projects; c) how two classes can enter into a live debate/discussion on a predetermined subject using telecommunications, and how that discussion can bring excitement and better understanding of a topic. The presentation will also explain the methodology for planning between teachers, the classroom preparations, methods for implementing as well as follow up activities. Further, the presentation will provide the opportunity for those present to discuss with both groups of students what they perceive to be the benefits of such an activity. Handouts describing the how-tos will be on hand.

Revolutionary Classroom (T2-207A)

Integrating Technology into a Middle School Microsociety Curriculum

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Key words: microsociety, middle school, integrated curriculum, multi-grade level, career oriented, dropout prevention

Abstract

This presentation describes an innovation in middle school education designed to "grab" frustrated learners. The integration of technolgy into a middle school microsociety curriculum was accomplished by teaming seventy-five students in grades six, seven, and eight with four teachers who presented an integrated curriculum which was career oriented. Macintosh computers, CD-ROM drives, laserdisc players and a variety of software was utilized.

Project Description

The Microsociety Technology Team at Lakeview Middle School in Winter Garden, Florida, represents a revolutionary approach to middle school education in a variety of areas. The use of Macintosh computers enhances the integration of the curriculum for multi-grade level academic instruction and serves as a necessary tool to students as they work at jobs in a school microsociety. Seventy-five students in grades six, seven and eight learn basic skills by passing through integrated curriculum streams built around such topics as energy, water, government, sky, and earth. To individualize the acquisition of basic skills, the team teachers use Skills Bank II software, each student having his or her own computer record of progress. ClarisWorks is utilized for word processing of research papers, English assignments and team newsletters. Telecommunications with ClarisWorks enables students to communicate globally using the Florida Information Resource Network, (FIRN), as a gateway to the Internet. A team database allows the teachers to have easy access to team information at any time. *HyperCard* software provides a creative avenue for student multimedia reports on many topics studied, as well as team autobiographies and team geographical maps. The classrooms are Ethernet networked and Appleshare v3.01 fileserved to maximize computer use.

Each student on the team has one or more microsociety jobs ranging from working in food services to being a team lawyer. Students hired in the microsociety print shop work on a team newsletter and creation of team birthday greetings, banners, and a team telephone/address book. The Micro Tech Corporation is a conglomerate with many companies including a school Supply Store, Scientific Research Association, Meteorological Service, Horticulture Company, Food Services Industry, and Cinema Theatre Group. Paychecks are issued once a week with students earning three dollars per hour for basic academic work: one dollar for attending, one dollar for best effort, and one dollar for good conduct. Pay for "micro" jobs is in addition to academic pay. Students run a team bank which gives loans, sells checks, and offers all banking needs. Banking for the microsociety is handled through spreadsheets using ClarisWorks and Checkbook, a program from Interact. Throughout every facet of the school day, technology is utilized, learning is meaningful, and students enjoy discovering the working world.

In order to motivate the students of today who live in a world of visual images and mass media, educational experiences must be positive and meaningful and must create within the students a need to know and a vision of what the future will hold for them.

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Revolutionary Classroom (T2-207B)

Immersion Problem Solving with the "Jasper" Series

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Key words: problem solving, mathematics, cooperative learning, situated learning, anchored instruction, instructional technology

Abstract

Fall of 1992 a rural Northeastern fifth grade mathematics classroom took 3 months from its traditional Addison Wesley text instruction to engage their students in "anchored instruction," using the problem-solving videodisc series "Jasper" (for a description of anchored instruction see the Cognition and Technology Group at Vanderbilt, 1990, 1992; and Young, 1993). Instruction included viewing three computer-interactive "Jasper Series" videodisc problem situations (available from Optical Data, Inc.), problem solving in dyads, two lectures using direct instruction on the topics of decimals and measurement, plus classroom and follow-up activities designed to extend and enhance the problems across the curriculum. Group data suggested that students who are immersed in a few rich realistic problem situations, provided through interactive video and extended through telecommunications, can develop mathematical and scientific knowledge along with higher level thinking

skills (specifically planning), general skills (specifically creativity), and learning skills (specifically information finding). This success is attributed to the characteristics of complex realistic "situated learning." Our presentation highlights the innovative aspects of the "immersion" classroom, such as fostering parent and community support within this context, and the collaboration between K-12 and higher education professionals.

Discussion

Fall of 1992 a rural Northeastern fifth grade mathematics classroom took 3 months from its traditional Addison Wesley text instruction to engage their students in "anchored instruction," using the problem-solving videodisc series "Jasper" (for a description of anchored instruction see the Cognition and Technology Group at Vanderbilt, 1990, 1992; and Young, 1993). Instead of lectures, worksheets and homework problems on decimals and measurement, the students were immersed into a complex realistic problem solving situation. In fact in 3 months, the students solved 3 problems. Each problem represented a realistic situation in which middle school mathematics, planning, information-finding, and cooperative group problem solving could be used to solve an everyday kind of problem. Students were immersed in these problems and after solving them, were engaged in related activities that enriched the problem context. This was problem solving in depth rather than the development of fluency with mathematical procedures across hundreds of worksheet problems. Our goal was to emphasize problem solving and other higher order thinking skills, such as planning for complexity and information finding across distributed sources along with fifth grade mathematics topics such as decimals, ratios, and measurement. The content of the problems took us across traditional subject domains, from mathematics to science, geography, reading, writing, and physical education. Interactive videodisc technology and telecommunications played a key role.

Instruction included viewing three computer-interactive "Jasper Series" videodisc problem situations (available from Optical Data, Inc.), problem solving in dyads, two lectures using direct instruction on the topics of decimals and measurement, plus classroom and follow-up activities designed to extend and enhance the problems across the curriculum. Activities included a relay race (timed in an attempt to beat the 7.5 min./mile rate of a boat featured in the video), construction and testing of boats designed from aluminum foil, conducting a fifth-grade interest survey, and E-mail communication with "Jasper" on-line (with responses given in-character by UConn graduate education students). Resources from the community were brought to the classroom, including a local veterinarian to discuss injured wildlife, a local television news executive to discuss how to write about and describe the problem incident, a local boater to show the equipment mentioned in one of the stories, and a local pilot who assembled an ultralight airplane in the school parking lot.

Throughout the three months, all classroom work was videotaped, ethnographic field notes were taken on 2 targeted student dyads, and pretesting / posttesting was done on this class and a similar "Control" class in the same school. Group data suggested that students who are immersed in a few rich realistic problem situations, provided through interactive video and extended through telecommunications, can develop mathematical and scientific knowledge along with higher level thinking skills (specifically planning), general skills (specifically creativity), and learning skills (specifically information finding). Immersion students also outperformed their peers on a test of reading comprehension, showing that immersion in a complex mathematical problem on video can benefit literacy skills— but this finding was restricted to reading analogous content (a story about a river) and was not shown for reading unrelated content (a story about horse racing).

This success is attributed to the characteristics of complex realistic "situated learning" (e.g., Brown, Collins, & Duguid, 1990; Greeno, 1989; Cognition and Technology Group at Vanderbilt, 1990, 1992; Collins, Brown and Newman, 1989). Situated learning is described as being based less on memory and more on the tuning of perception, drawing on the psychology of James Gibson (1979). Such learning is argued to provide greater transfer from the learning context (classrooms) to the real world of everyday problem solving.

This classroom intervention continues during the 1993-1994 school year. Our presentation highlights the innovative aspects of the "immersion" classroom, such as fostering parent and community support within this context, and the collaboration between K-12 and higher education professionals. We plan to present videotaped highlights of classroom activities as well as qualitative and quantitative research summaries regarding the activities.

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Special Session (T2-208A)

Integrating Technology into the Curriculum—or—This "Techie" Stuff Really *Does* Work!

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Key words: integration, curriculum, cooperative learning, critical thinking, technology plans

Abstract

M.S.D. Southwest Allen County in Fort Wayne, Indiana, has made a unique, thorough, and innovative commitment to integrate technology into the curriculum. Technology is not an add-on to the curriculum, but is a tool with which the students can learn, access additional resources, and experiment with multimedia projects. It has been shown that students achieve more, show enthusiasm toward learning, use cooperative learning teams, and illustrate higher order critical thinking skills than they did with the more traditional teaching techniques.

Our session will address the following topics:

- A brief description of our Technology Plan and its implementation
- A brief outline of what technology exisits in our schools with rationale for the selection of the technology that was chosen
- Samples of actual student work incorporating technology
- Pointers and tips on how to get teachers involved with technology, staff development and training plans, technology and information skills curriculum guidelines and samples, formation of technology committees.

Special Session (T2-302A)

The Global Classroom Youth Congress: Student Recommendations for Global Networking in Schools

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Key words: global, networking, KIDLINK, I*EARN, telecommunications, K-12, implementation

Abstract

The Global Classroom Youth Congress is an opportunity for students to become intellectual participants in the dialogue on global networking in schools. As students are on the forefront of developments in online instructional environments, the reports of their experiences and of their recommendations for improvements are essential. In many cases students are the initiators and moderators of some of our most notable initiatives, and thus their expertise and enthusiasm is of great service to the entire educational community. Student participants in the Global Classroom Youth Congress come from a wide variety of networking initiatives, such as KIDLINK, I*EARN, America Online, and others. As delegates to this "congress" they are asked to make specific recommendations addressing one of three thematic areas of importance to global networking. These are:

1. Academic and Curricular
2. Cultural and Lingual
3. Technical and Implementation

In past sessions, students have made many important contributions, such as, for example, calling for greater coordination between foreign language and computer science departments, creating a dual credit system for comprehensive telecommunications projects, and having a full range multicultural resources available online (Itzkan, 1994). It is hoped that by bringing the voice of youth into the information age, they will be assured a role in the development of tomorrow's international and cross generational online environments.

Reference

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Project (T2-308A)

Developing Multimedia Teaching and Learning Resources "From Below"

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Key words: multimedia, teaching resource

Abstract

The development of multimedia teaching and learning resources by educators is both desirable and possible. Recent developments in both computer hardware and software mean that teachers and students have the ability to develop and control the learning environment in a genuinely interactive way.

The thrust of the session will be to share the experiences of the development of such materials by teachers in the UK. The basis of the presentation will be the development and educational rationale of The Crucible CD-ROM project. Advisory teachers, working with the Arthur Miller Centre at the University of East Anglia, have produced a comprehensive teaching and learning resource for students studying English, Drama and History in high school through to college.

Arthur Miller is widely regarded as the outstanding English speaking playwright of the century. His play The Crucible is one of his most popular plays and is performed every day somewhere in the world. Working with Arthur Miller himself we have produced what we believe to be a unique educational resource. The project has already been "highly commended" by the British Interactive Multimedia Association and a major review in the Times Educational Supplement (the major UK educational journal) regarded the work as a "tour de force".

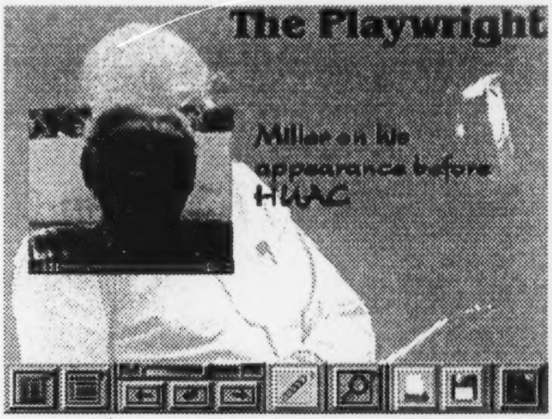

Figure 1. Students have "access" to the playwright

Students not only have access to the complete text of the play—with accompanying analysis of the drama and its characters—but also have access to the playwright himself via an exclusive interview in which Miller talks about all aspects of The Crucible. The CD-ROM contains over 600Mb of digital movies including actors, from The Youth Theatre at the Young Vic in London, talking about their roles in the play.

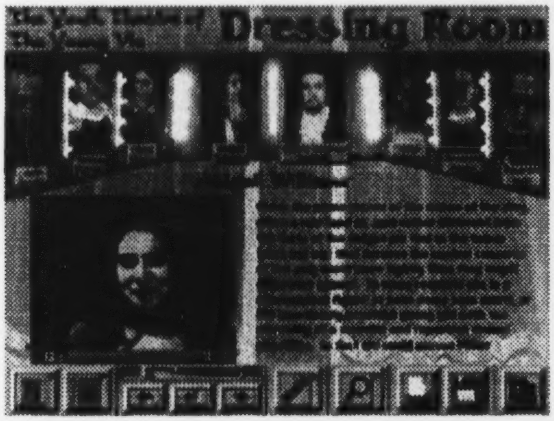

Figure 2. Actors talk about their roles in the play

A student using the program can search, print and save information from the CD-ROM. This includes special sections on the background to the play as well as original source material (pictures and text) from the seventeenth century allowing comparisons between the play and real events. The views of critics and professional actors/directors are also included.

The session will deal with the processes and issues raised in the development of multimedia projects "from below" by educators. This will include the importance of devising an appropriate user interface so as to make the wealth of material easily accessible to students of a wide range of academic ability.

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Project (T2-308B)

Using Multimedia and Telecommunications Tools to Create a Student Anthology

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Key words: language arts, hypermedia, telecommunications, expanded books, electronic books, annotated text, toolkit

Abstract

During the 1993-1994 school year, Dan Lake, a technology consultant and Kristie Bliss, a language arts teacher, collaborated to create a student-made anthology containing various writings both produced and found by junior high school students. The outcome of the work done by the students was an electronic "Anthology" of work related to a cross-disciplinary project involving research of selected artists and creation of art work in the style of the selected artist. Poetry, narrative material, and student generated writing were all combined into the "Anthology" and then annotated by digital images of the students and their created pieces.

The Idea

The outlined project was first suggested by lines in an article by Linda Polin. Linda wrote: "The Expanded Book toolkit allows you to import and arrange text and make hypertext-like connections to text notes, digitized audio, still or motion video, graphics, and more." (Polin, p. 30)

Dan Lake saw this quote as an invitation to use the mentioned toolkit to transition language arts teachers into a new paradigm of writing, one being "layered" and not structured in traditional ways. Additionally the term "..import and arrange.." implied the use of standard text files—the kind moved on the Internet. Using this toolkit could demonstrate a meaningful outcome through a convergence of two technologies: hypermedia and telecommunications.

The Proposal

Kristie Bliss was a language arts teacher, teaching grades 7-8 in Cortland, New York. She had 5 Macintosh Computers set within her classroom, with access to 25 Centris 610s located within her school. She used *ClarisWorks (Claris)*, *The Writing Center (The Learning Company)*, *SuperPrint (Scholastic)*, and other software running under an AppleShare network. Her computers were connected via a Mac Server 95 to a wide area network called Technology Network Ties, which provided an interim gateway to the Internet. All system level and curriculum level training and support was provided by the Learning Technologies Department of the Central New York Regional Information Center.

Dan Lake approached Kristie, asking if she would be willing to work with a product that could be installed in her room. The proposal was that she learn the product and use it to create an "electronic" book with hypermedia linkages to images, sounds, and text. It was further proposed that she be taught to collect text from Internet searches, and teach her students to do the same. The key component of the proposal was that she integrate the telecommunications resources with multimedia resources using the provided tools. For her efforts, Kristie would be given Internet access, the *Voyager Expanded Book Toolkit*, and the possibility of showing the outcome to a national audience. Kristie accepted the challenge. The project was underway.

The Project: Underway

At the time of this writing, Kristie has received initial training in the use of the *Voyager Expanded Book Toolkit* and is collecting text from her students. She is working with an art teacher to create an anthology of information about specific, student-selected artists. Students have been working within the art class to create work that reflects the style of their chosen artists. With Kristie's aid, they are researching information about the artists and their times. Using telecommunications, the students are searching for information online, using *Gopher* software developed at the University of Minnesota and the *Veronica* search engine used at a number of sites that use *Gopher* Servers. In March they will use *ClarisWorks* to modify and re-save the captured files as text files. Then, they will import and place their material into a "class anthology". They will add their own narrative pieces and edit and organize the class work. During April and May, they will digitize selected photos of themselves and their art work to annotate the text. Sound files will be included and the complete work will be published in electronic format as well as print format. The final outcome will be shown in Boston in June.

In Conclusion

One of the long range goals of the State of New York is that "Multimedia and hypermedia applications would be integrated within and across all curriculum areas." (Office of Elementary and Secondary Education, p. 22)

A second long range goal is that students would have "Access to library and multimedia resources wherever they might be located." (Office of Elementary and Secondary Education, p. 22)

Linda Polin's article states: "Perhaps as people write with the interface in mind, instead of simply porting text into it, we shall begin to see the restructuring of extended writing." (Polin, p. 30)

What happens AFTER this project is completed in June will provide some measure of how classroom teachers will integrate powerful capabilities into their teaching days. Though they will begin by "*...porting text...*", the hope is that they will soon master a new format for information processing and dissemination.

References

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Society Session (T2-310A)

How to Build Your Own Local Area Network (ECMI)

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Key words: LAN, ethernet, TCP/IP, Internet

Abstract

This presentation provides the basic knowledge to the design and implementation of a low cost local area network (LAN) of PCs and MACs (from Apple Computers). In particular, the LAN shall be an Ethernet that runs a TCP/IP network software with access to the Internet.

The implementation of three popular Ethernet/IEEE 802.3 standards, Thick (10 Base 5), Thin (10 Base 2) and TP (10 base T) will be presented. This includes the selection, installation, and configuration procedures for all necessary hardware components such as cables, network controllers, and hubs. On the software side, we recommend the use of two public domain TCP/IP network software packages: the NCSA Telnet for PCs and for MACs. These packages can provide the most commonly used network applications such as: TELNET for remote log-in and FTP for file transfer. Other TCP/IP applications such as LPR (for remote printing) and MAIL can be added on the NCSA packages later on. Finally, the network hookup to the Internet will be introduced.

Society Session (T2-311A)

Look at the Role of A.P. in the Computer Science Curriculum (ISTE/SIGCS)

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Key words: A.P., computer science, curriculum

Abstract

For years now, the Advanced Placement test has had a significant effect on what gets taught in high school computer science. This panel session will examine the present and future influence of the Advance Placement test on the high school computer science curriculum , with the goal of promoting a thoughtful discussion on this important and often hotly-debated issue. The panelists, drawn from both high school and university, will discuss a number of questions relating to the continued relevance and influence of A.P. Areas of discussion will include the role A.P. has played in furthering computer science instruction at the high school level and how this role may be changing in light of a number of new curriculum initiatives (such as the ACM model curriculum). Panelists will look at the question of whether A.P. continues to advance the curriculum or is mandating the use of outdated technology through its language specificity. It will also focus on the future of A.P. and the future of the high school computer science curriculum as a whole.

Special Session (T2-312A)

Supporting Learning Outcomes Through Network Communities

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Key words: science, high school, network, collaboration, staff development

Abstract

The Community of Explorers project, is identifying and characterizing the important factors for establishing a robust and educationally productive network community of high school science teachers. We have Internet-enabled science inquiry software and, together with the National School network Testbed project, provided full Internet connectivity for teachers in Massachusetts and San Diego. The. network's purpose is to help teachers, students, and scientists to communicate, collaborate, solve common problems, and to share ideas for classroom investigations and instructional activities. The technology enables collaborators to exchange simulations, data and, in general Macintosh files, as well as plain text. The community presently consists of twenty seven high schools in California and Massachusetts.

A robust network is one which is self-sustaining, and which- provides useful resources for a diverse population of teachers. Within the view provided by activity theory, we are determining the factors that contribute to a critical level and lasting duration of peer-to-peer interaction with minimal outside support, beyond the more obvious factors as technology ease-of-use or continued project funding. Useful resources range from modules which teachers may easily plug in to their curriculum, to accounts of other teachers previous experiences, to the ability to collaborate in problem solving or research on science teaching- and learning. The teachers perception of value or ability, and hence their interest in maintaining **network** communication, depends upon the personal perspectives of the nature of effective teaching and learning.

An educationally productive network is one which not only provides teachers with the above resources, but one which supports the teachers in rethinking or re conceptualizing their teaching practice. Going beyond espoused theories, this is measurable as a change in their teaching practice, and ultimately in the learning outcomes of students as well as a change in the needs of the network community. In this talk we will describe our ongoing research in this area and our preliminary results.

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Special Session (T3-BRCA)

Immersion in Artificial Realities for Education

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Key words: artificial reality, immersion interfaces, visualization, distributed simulation

Abstract

New information technologies are empowering old models of teaching/learning more powerful than group presentation, but never before affordable and sustainable in classroom settings. Learning by doing, students actively constructing knowledge, collaborative learning across distance, teachers and remote experts mentoring student apprentices, and interdisciplinary learning based on authentic problems contextualized in real world settings are perennial visions for education whose time has finally come. High performance computing and wide-area, broad-band telecommunications are the key technological drivers freeing education from constraints of time and geography. As today's multimedia approaches evolve into distributed simulation, virtual communities, and artificial realities, education will increasingly become immersive and interdisciplinary, weaving together in-class instruction with out-of-school experiences.

Teachers have long used simulations to mimic simplified real-world environments. However, artificial realities are qualitatively different than small-screen models because entering and exploring a virtual "world" is a more intense mode of human-machine communication than "conversational" interfaces in which the user commands the computer to do something, then waits for a reply. The key capabilities that artificial realities for learning add to current simulations are:

- telepresence (perceived simultaneous presence in a synthetic environment by geographically separated learners), and
- physical immersion (the subjective sensory impression that a user is "inside" a synthetic environment comprehensive and realistic enough to induce the willing suspension of disbelief).

The induction of immersion and telepresence has at least three dimensions:

1. Inducing an sense of physical immersion and presence involves manipulating human sensory systems (especially the visual system) to enable the suspension of disbelief that one is surrounded by a virtual world. The impression is that of being inside an artificial reality rather than looking through a computer monitor "window" into a synthetic environment: the equivalent of diving rather than riding in a glass-bottomed boat.
2. Inducing actional immersion involves empowering the participant in a synthetic environment to initiate actions that have novel, intriguing consequences. For example, when a baby is learning to walk, the degree of concentration this activity creates in the infant is extraordinary. Discovering new capabilities to shape one's environment is highly motivating and sharply focuses attention.
3. Inducing a participant's symbolic immersion involves activating powerful semantic associations via the content of a synthetic environment. As an illustration, reading a horror novel at midnight in a strange house builds a mounting sense of terror even though one's physical context is unchanging and rationally safe. Invoking intellectual, emotional, and normative archetypes deepens one's experience in a synthetic environment by imposing an complex overlay of associative mental models.

Instructional developers have historically stressed the importance of the latter two dimensions of immersion in the design of computer-based educational experiences. Now, advances in interface technology also enable physical immersion and telepresence to enhance learning in virtual worlds tailored for education. As the installed base of technology in our society evolves from television into multimedia, distributed simulation and virtual reality, the ways educators can induce collaborative immersion to empower mastery of new material are rapidly multiplying.

Special Session (T3-201A)

ACM Model High School Computer Science Curriculum

Moderator:

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Task Force Members:

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Carol E. Wolf, Pace University, NY

Key words: ACM, staff development, computer science, high school, curriculum, model

Abstract

A task force of the Pre-College Committee of the Education Board of the ACM has published a model high school computer science curriculum. A summary appeared in the May 1993 *Communications of the ACM*. The full report is available for purchase from the ACM. The report identifies seven areas which provide a broad introduction to computer science for high school students. Five of these areas are further subdivided into topics which are considered core, those which are recommended for all students, and those which are felt to be optional. The appendices of the report contain a number of different ways to incorporate these topics into courses. These methods range from approaches which rely heavily on programming to ones emphasizing computer applications.

The task force is now preparing to offer summer workshops for high school teachers with follow up during the school year via computer networks. Classroom materials will be developed before the workshops are held and then modified and expanded by the participants.

Panel members will describe how the workshops will be conducted. In particular, the panel will

- review the model curriculum
- suggest form and content of materials tailored to the high school setting
- suggest methods for active teacher participation in materials development
- provide suggestions for developing teacher knowledge and skill.

Special Session (T3-202)

Action Research and the Revolution of Teaching with Technology

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Key words: action research, teacher research, staff development, school restructuring, reform, integrated curriculum, Logo

Abstract

This session includes an overview of the action research process, examples of a nationally funded and a locally supported action research collaborative, and a discussion of how technology action research supports teacher growth and change.

An overview of the action research process will include the following:

- generating a question
- designing a research plan
- collecting data
- interpreting results
- sharing findings with colleagues

Examples will be drawn from the 1990-91 national Logo Action Research Collaborative (LARC) facilitated by Dan and Molly Watt, Educational Development Center with specifics from the Madison site, and its off-spring, the 1992-93 Madison area Technology Action Research Collaborative (TARC). Discussion will include expansion of the collaborative to topics beyond Logo such as telecommunications and spreadsheets; movement from a nationally funded project to a locally funded group; and the logistics of setting up and sustaining a teacher run action research collaborative.

A discussion will highlight the benefits to a school district, students, and teachers with information about staff development, publishing, and recognition that has been a direct result of work in action research collaboratives. The audience is invited to join in the discussion of ideas and issues presented at this session.

Special Session (T3-203A)

Educational Partnerships: Sharing Students, Teachers and Resources

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Key words: Time Share, opportunities, enhancement, motivation, creativity

Abstract

The major objectives of this program were 1) to provide alternatives to daily study/lecture units 2) to create opportunities for students and teachers to work effectively outside the classroom 3) to enhance assignments by providing unlimited access to media technology 4) to provide valuable work time for teachers and students in multiple environments 5) to give all participants time and space for the purpose of gathering information and sharing resources 6) to create an environment that will motivate staff to explore new teaching techniques 7) to encourage students to take a more active role in their education 8) to provide special opportunities for parents, working with staff, to learn and use merging technologies.

The anticipated outcome will be the strengthening of student skills to gather and implement research data, to find a meaningful application in the use of the latest technology, to become resourceful, creative and to assume leadership roles in future projects. Teachers will be motivated to explore new teaching techniques, provide a more creative and challenging study unit and take advantage of time provided through sharing students to become more productive. Parents working with home computers that access school file servers, will be able to assist their children in working with all computer generated software. Parents then become an important link in the educational development of their children.

Introduction

Ever wish you could be in two or three places at once? Have fewer students and more time to work with them?? Learn or at least coexist with the new computer technology....while knowing your students are moving ahead at their own pace?? How about a break from those daily routines of being a classroom teacher? You know..... the ones that sometimes leave you as grumpy on your way to school as you were when you went home the day before!!

If you have ever wondered how you might break away from schedules, lessons plans, lectures and tests, and at the same time teach and help your students to be just as creative as they can be, then spend some time with this group of Huron High School staff members who have a powerful ally in the new technology that has only winners for this group of hard working students.

These TIME SHARE projects were each two weeks long. They involved the Media Center staff and participating classroom teachers whose lectures were videotaped in advance of each two week long unit, then archived in the High School Media Center. They were then viewed during the duration of the ten day assignment at a place and time of the students choosing. Students could take them home to watch and study on their own video players. Menus of other class and media center assignments for the individual and group projects were presented to each of the classes and then stored on media center computer hard drives for student access anytime during the two weeks. Students were also required to take tests, quizzes and leave summaries of their work on computers throughout the project. Students with no computers at home, were permitted to take school computers home with them. The High School Media Center remained open two evenings a week so media staff could provide assistance to teachers, students and parents (who needed it).

Teachers and students were free to be wherever they chose during those ten days. Each student had individual as well as group assignments to complete during the project. With lectures already taped and available to students, teachers were free to work with them individually or as group throughout the entire two week assignment. Students shared assignments, took

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quizzes, tests and homework already stored on network computers while teachers were able to grade, monitor and comment on their efforts without collecting a single document. Students and teachers were assisted by media staff in the use of all media center based technology.

Parents were invited to participate in the program by attending the daily classes and the evening sessions. This was a particularly good move as it provided us with a unique opportunity to explain this unique "out of class" concept and answer their questions. They were very supportive, helpful and the follow up has been positive.

Special Session (T3-204A)

Speech Recognition Technology: A Mediator of Writing for Students with Learning Disabilities

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Key words: learning disabilities, speech recognition, writing, communication, elementary, special needs

Abstract

In schools the primary tools of writing are pen and keyboard. Occasionally teachers encourage students to dictate to a tape recorder or directly to a paraprofessional or volunteer. This dictation requires that someone transcribe each student's spoken words, a labor intensive process. Is it possible for technology to eliminate the human step? Consider this scenario: a student speaks into a microphone attached to a computer. The student's utterances appear on the screen as the student speaks. The student can see the words immediately, and the need for transcribers is eliminated. Can this facilitate student writing? We know that some business executives use the dictaphone to do much of their writing because it is faster for them and makes them more productive (Halpern & Ligget, 1984). Writing researchers have examined the role of the mode of writing for students learning to write. These researchers (Berieter & Scardamalia, 1987; MacArthur & Graham, 1987; Montague, Graves, & Leavell, 1991; Newcomer & Barenbaum,1991) have also considered whether fluency influences the amount of writing, the complexity of the writing, writing revision and writing quality. Particularly for students who find writing by pen difficult, it reasonable to investigate whether an alternative mode of writing may help them with their classroom writing.

Purpose of Study

This article describes the lessons used to teach three elementary students with learning disabilities to use voice recognition technology for written communication. It also describes and evaluates the results of combining this technology with pre-writing strategies adapted for student dictation.

Sample

The special education resource teacher in a large urban Southwestern elementary school identified three intermediate grade students with normal or above average intelligence who had problems with written communication. Based on oral participation in social studies or science class, students would be indistinguishable from their general classmates. However, their written work does not reach the level of their classmates. The students' general classroom teachers said that if these students would turn in any written work, that would be an improvement.

The Technology

Students used two *IBM* products: Voice *Type* , a voice transcription program and *Primary Editor Plus*, a word processor appropriate for elementary students. *VoiceType* runs on any *IBM* compatible computer equivalent to *PS/2* or greater with six Mb of RAM and a 30 Mb hard disk drive or larger.

Data Collection

This researcher took notes during each session. Most of the sessions were videotaped. Notes were supplemented by the transcription of key segments of the videotapes, including the prewriting activities and the interaction between the students and the voice translating program. In addition each draft that students dictated was saved and printed. The researcher met with each student approximately 13 times for approximately 30 minutes per session.

Lesson Content

Each session included instruction and practice in the use of the technology and students using the technology to compose a piece of writing through dictation. Lessons included most of the following elements:

- discussion of writing goal for the day (e.g., my teacher wants me to work on my social studies report),
- setting of subgoals for the lesson (e.g., generate topics to write about, write an outline of the report),
- introducing or reviewing features of *Primary Editor Plus (PEP),* the word processing program,
- introducing new *Voice Type(VT)* procedures and commands or reviewing them,
- pre-dictating activities (prewriting activities),
- dictation,
- reading and revising what *VT* transcribed, and
- preparation for the next meeting by discussing the student's accomplishments, the plan for the next meeting, a discussion of how well the technology worked and would perform the next time it was used.

Student Accomplishments

An analysis of videotapes of each student's dictation process, students' comments, and researcher observations provided evidence that these students did learn to use the word processor, Primary *Editor Plus* , and the transcription software, *Voice Type* to set writing goals and to plan for dictation. Although students learned to use *VoiceType*, the program recognized less than 75% of the words student dictated. Teaching *VoiceType* to recognize new words slowed the students' dictation process. However, the dictation process was enhanced by pre-writing strategies such as oral rehearsal and key word banks.

Recommendations

Although this technology holds some promise for learning disabled students at the present time, the researcher recommends that educators and parents wait until the technology recognizes a higher percentage of words before adopting the technology for writing. Students became less fluent when correcting *VoiceType's* recognition errors and teaching *VoiceType* new words. However, parents and educators are encouraged to use pre-dictation strategies (oral rehearsal and word banks) with students who dictate into a tape recorder or to an aide, parent, or cross-age tutor. These strategies may increase student willingness to compose and the amount they write.

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Voice Type. IBM Direct, PC Software Dept., One Culver Rd., Dayton, NJ

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Internet Room (T3-206A)

Taking Local Control of the Internet in Schools and Districts

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Key words: Internet, K-12, National School Network Testbed, domains

Abstract

A rapidly growing number of K-12 schools and districts are becoming their own Internet domains. Instead of accessing only remote Internet resources or logging into remote hosts for E-mail and bulletin boards, these schools and districts are putting their own resources up on the Internet for both local consumption and access by students and educators around the international Internet. Schools and districts are creating databases of lesson plans, creating student newswires, setting up project bulletin boards, and hosting virtual communities on their own servers. While such schools and districts number in the low 100's at this point, the numbers of new K-12 domains is accelerating and is expected to be in the 1000s by NECC '95. Educators from schools and districts that are operating their own Internet servers as part of the NSF-funded National School Network Testbed will come together in the panel to share their experiences. These are pioneers in constructing educational value with this technology. They will bring a unique perspective on the Internet, showing how schools and school districts can be constructors of, not just consumers on the information superhighway.

Revolutionary Classroom (T3-207A)

The Revolutionary Algebra Classroom: Instruction Reflecting How Students Learn Mathematics

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Key words: mathematics, algebra, instruction, computer, inductive, deductive

Abstract

Formal mathematics is presented deductively but human learning is primarily inductive. Even mathematicians learn from diagrams and examples before abstracting. Students learn mainly by generalizing from examples, not by logical deduction. They emulate sample problems because that works best. Computers have been incorporated into mathematics instruction without changing its fundamentally abstract to concrete orientation. In the revolutionary algebra classroom the student begins by using software to pose problems, to demonstrate sample problems, and for assistance in entering step by step solutions. The computer screen emulates an "intelligent blank sheet of paper." The instructor originally serves as a tutor, available when needed. Later, the instructor presents abstract principles to a student audience now prepared for a higher level of abstraction.

Introduction

Mathematics is organized deductively. Arguments proceed from axiom and definition to theorem and proof to application and example. Formal mathematics progresses from the abstract to the concrete.

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Human learning is primarily inductive. From the moment of their birth, human infants consciously and subconsciously seek patterns among the stimuli they detect. They generalize compulsively and incessantly. The compulsion to abstract and to generalize from examples continues throughout each human lifetime. It gives rise to religion and science, to myth and art and mathematics. Human learning progresses from the concrete to the abstract.

Mathematics Instruction

The deductive character of formal mathematics and the inductive character of human knowledge acquisition inevitably collide in mathematics education. Traditionally, instructors present concepts and principles and students develop and demonstrate their mastery by applying them to problems. However, definitions of unfamiliar concepts routinely mystify all but the most gifted students. Few students are prepared for generalities such as the ring axioms at the beginning of elementary algebra. This encourages memorization without understanding.

In a 1990 article, Fields Medal winner William Thurston of Princeton writes:

> "Studying mathematics one rule at a time is like studying a language by first memorizing the vocabulary and the detailed linguistic rules, then building phrases and sentences, and only afterwards learning to read, write, and converse.... The rules and patterns are much harder for people to learn explicitly than is the language itself."
>
> "...There is a natural tendency, in teaching mathematics, to use the logical order and to explain all the techniques and answers before bringing up the examples and the questions, on the supposition that the students will be equipped with all the techniques necessary to answer them when they arise."
>
> "...The best psychological order for a subject in mathematics is often quite different from the most efficient logical order." [1]

Active mathematicians rely heavily on examples, diagrams and other concrete instances. The fitting of learned material into a deductive framework or the production of a deductive theory is merely the final stage in the process of learning or creating new mathematics.

Students learn mathematics in practice more by pattern recognition than by logical deduction. They prefer to search the textbook and class notes for similar problems to emulate rather than to apply general rules, not out of perversity or hostility to principles, but because they find that emulation works.

Computers in Instruction

Current computer assisted instruction typically retains the abstract to concrete orientation inherited from previous instructional approaches. Live or recorded instructors are used to present abstract principles. Computers are used to follow up, sometimes by offering drill and practice on the concepts presented by the instructor and sometimes by offering opportunities for further exploration. This leaves the instructor in the untenable position of initially trying to explain abstractions to students unfamiliar with concrete instances of these concepts.

The Revolutionary Algebra Classroom

In the revolutionary algebra classroom, a student begins with software which demonstrates solutions to sample problems and poses similar problems for which it offers step by step assistance. It uses the screen as an intelligent blank sheet of paper on which the student works out a solution to each problem. It explains each step in concrete terms as it demonstrates, or assists the student in completing, a step by step solution. It accepts any correct solution method and adapts its own solution method to the student's entries, encouraging both exploration and shortcuts.

The instructor initially serves as a tutor, helping individual students with questions which they cannot resolve with the help of the software. Then, after students obtain the necessary concrete mastery, the instructor discusses abstract versions of these same concepts with students who are now ready to understand such abstractions.This instructional model exploits the computer for repetitive low level tasks which computers perform best. It allows the instructor to convey more sophisticated concepts and generalizations later, and to a more sophisticated student audience. Most important, it permits students to develop mathematical mastery by progressing from the concrete to the abstract.

The software described and demonstrated here is available from the author under a free site license.

Reference

[1] Thurston, William P., "Mathematical Education," Notices of the American Mathematical Society, Volume 37, Number 7, September 1990.

Revolutionary Classroom (T3-207B)

Computer Math with Spreadsheets

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Key words: computer math, spreadsheets, individualized learning

Abstract

My presentation is based on the Computer Math course which I teach to 11th and 12th grade students at The Blake School in Minneapolis. The course is designed to help students 1) feel more comfortable using the computer as a tool, and 2) better understand a variety of mathematical problems by approaching them in a new way. During the first half of the course we concentrate on spreadsheet applications (graphs, systems of equations, sequences, series, chaos, cash flow, number theory, extreme values, and probability), and during the second half of the course we create *HyperCard* stacks. The course takes a highly individualized, hands-on approach to mathematics instruction.

The computer helps my students gain a much better understanding of mathematics. It helps bridge the gap between the concrete nature of arithmetic and the abstract nature of higher mathematics. It helps students see relationships more clearly. It helps break large problems into smaller, more manageable, ones. It helps remove the emphasis on tedious computation and rote memorization, placing it instead on the understanding of basic concepts, where it belongs.

Students in my class hear no lectures. They are assigned no homework. They take few tests or quizzes. Instead, they spend a full hour each day actually doing mathematics. Of all the mathematics courses I have ever taught, this is the one in which I have seen the greatest level of interest, self-motivation, concentration, involvement, effort, and overall learning.

Revolutionary Classroom (T3-208A)

Improving Written and Oral Expression Skills of Learning Disabled Students

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Key words: learning disabled students, multimedia, language expression

Abstract

Special needs students typically experience poor academic success in a conventional classroom setting. In response, effective teachers learn to use a multi-modal approach for building literacy skills. While students may have a good grasp of the topic, even with remediation written composition remains a difficult task. The challenge, then, is to offer to the students an expanded opportunity to express their knowledge through the use of multimedia authoring applications. Students are able to use sound, still images and moving images to demonstrate their integrated knowledge of a topic. Using examples of student projects, this presentation will feature sample lesson plans, outlining/idea-mapping applications, as well as Persuasion and *HyperStudio*.

Revolutionary Classroom (T3-208B)

Kindle the Fire: Multimedia and Special Education

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Key words: multimedia, special education, multiple intelligences, thematic

Abstract

Thematic multimedia units for a primary self-contained special education classroom. Non-verbal children. Camcorders, videodiscs, computers, puppets, live animals, *HyperCard* stacks, scanned pictures, crayons, dress-up, field trips, murals, stories, and animal fact books.

Laura Sanders works with a very special population of children. These children, ages 5 to 10, are largely non-verbal, some have neurological problems, some have visual, others have multiple physical problems, but all participate in Laura's classroom. They videotape animals, learn animal facts, design video sequences, select music, and do narration for their video documentaries. Those are just some of the magical things that go on in Laura's classroom. They have created a *HyperCard* stack of their animals, write fact books about the animals they are studying complete with word processing and scanned pictures, and perform animal puppet shows for the handicapped preschool program next door.

Based on Howard Gardner's Theory of Multiple Intelligences, and on what is known about learning styles, Laura has created a learning environment that is designed to enable her students to learn in the way they learn best, be it actively, verbally, visually, or tactile-kinesthetically. Centered around the study of animals, students learn the alphabet and the beginning letter sounds of the animal. Facts about each animal are learned (Cows have warm blood, Hyenas are mammals, Iguana mothers don't take care of their babies) and children visit, or bring into the classroom, or watch a video (last resort!) about each animal. Many activities center around each unit; math problems, science projects; all designed to fit the needs of Laura's learners.

Students have blossomed dramatically. Their verbal skills have increased, as has their attention span. They are more alert to the world around them, and have begun making generalizations from the material learned about the animals.

Laura and Patty will demonstrate student created projects, including their videos, talk about how the classroom was devised, and discuss with participants the ins and outs of working with this special population. Patty will also discuss staff development strategies for training teachers in using multimedia with their students.

Laura's classroom has been featured in the Apple videodisc, **Teaching, Learning, and Technology**, and also in a national teleconference sponsored by the U.S. Dept. of Education on using technology to improve education for students with disabilities.

Special Session (T3-302A)

Microsoft-Teacher Educator Partnership Grants: Diverse Approaches to Technology Infusion

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Key words: teacher education, educational technology, technology infusion

Abstract

This panel features teacher educators engaged in technology infusion efforts across the state of New York. Each panelist represents an institution that was awarded a Teacher Educator Partnership grant from Microsoft Corporation. These grants provided the recipients with state-of-the-art software, multimedia products, and instructional materials to enhance their on-going efforts to infuse technology wisely into their teacher preparation programs. The grant materials were provided for both the Macintosh and PC compatible platforms, thereby permitting the Teacher Education Departments to provide their students with technology experiences in the two most widely available computer environments. Although all of the higher education representatives received Microsoft- Teacher Educator Partnership Grants, the institutions that they represent vary greatly in size, location, and mission. In addition, the technology infusion models adopted by the institutionsU Teacher Preparation Programs have diverse elements and unique features. Each approach is briefly summarized in the following paragraphs.

Developing Technologically Competent Educators at Buffalo State College

The Elementary Education Department at Buffalo State College (BSC) is improving the technology (in)competence of many education majors by establishing a new integrated model to increase their technology skills. Majors take a technology competence course designed specifically for educators. The course provides students a broad, positive introduction to educational technology. In subsequent methods courses, students apply technology in content-specific ways. In field components and student teaching experiences, majors work in classrooms using the same resources they mastered on campus. In this way, majors practice using the technology instructionally under the guidance of knowledgeable supervising teachers and college faculty.

Telecommunicating with Student Teachers at Buffalo State College

The English Education program at Buffalo State College is developing technology infusion in teacher preparation courses for the secondary schools. In their programmatic courses, students are introduced to instructional technology through demonstrations and classroom experiences, culminating in focused training and experience for selected participants during student teaching. Placed in technology-enriched school settings, these students work in both Macintosh and IBM platforms, with a particular focus on Microsoft telecommunication programs for E-mail correspondence between themselves, their college supervisors, and their own students.

Technology Infusion Efforts at Pace University

Pace University is committed to integrating technology throughout the teacher preparation program. We have already trained half of our full-time faculty in the use of technology, and plan this year (due to the Microsoft grant) to extend that training to the rest of our faculty. Pace undergraduate core requirements include a computer science course. A special education section of that course uses Microsoft Works, and, after that training in their freshman year, all students are required to word process their papers. The computer science faculty involved in the education sections of the course incorporate multimedia training so that in the education courses we can focus to a greater extent on the integration of technology into the curriculum.

Technology Infusion Efforts at Plattsburgh State College

The education programs at Plattsburgh State recently entered the Information Age in a dramatic mannerQfaculty designated technology as a foundation of equal importance to other foundation courses. Our primary objective is to ensure that every education major graduates with experience using technology for productivity enhancement, professional development, and curricular activities. To achieve this goal we have made the following changes: revision of our Technological Foundations in Education course, promotion of technology applications for professional activities, integration of cooperative learning and interdisciplinary activities using technology in all methods courses, creation of telecommunication links for all majors, and completion of a multimedia classroom with Ethernet connections to the INTERNET.

Extending Technology Use by Teacher Educators at Cortland State College

Cortland State has a reputation for quality in teacher education. CSC's teacher education programs are heavily integrated with computer technology. Our faculty have integrated computer technology into methods courses and a required Computers in Education course all majors take as juniors. CSC has 20 IBM computers in three classrooms and a Macintosh lab which are both used extensively by education majors. In the computer course, we require the use of word processing, spreadsheet and data base applications. Objectives in our teacher preparation program include that students will: word process daily assignments and lesson plans, create databases for use in methods course lessons, use spreadsheets to create gradebooks, and telecommunicate with K-12 students via the INTERNET.

Special Session (T3-304A)

Using Technology to Support Lifelong Learning Communities: Four Models for Systemic Reform

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Key words: learning communities, lifelong learning, educational restructuring, systemic reform

Abstract

Panel participants in this Special Session are all actively engaged in the use of computers, multimedia, and/or telecommunications technologies in support of systemic school restructuring or curriculum reform efforts. At the same time, each of these efforts has involved extending the boundaries of individual classrooms or schools to enable participation in these reform efforts by much broader communities. Each presenter will thus share experiences and ideas about how technology can help support the emergence of new kinds of lifelong learning communities:

- Ted Kahn will describe how computer simulation and modeling tools and telecommunications networks in IRL's Middle School Mathematics through Applications Project (MMAP) support both an open-ended, "learning by design" approach to implementing the NCTM standards, as well as the emergence of a new kind of "learning community-in-the-making."

- Dave Master will show how his internationally acclaimed, student-run Rowland animated film-making classes have not only had impact on the surrounding professional film, multimedia, and entertainment community, but have also begun to affect student research and learning in many different subject areas outside of media studies.

- Denis Newman will discuss how schools that are part of the BBN National School Network Testbed are combining their local and wide area network connections in order to support restructuring. He will select network applications examples, such as elementary and high school collaborative research and online

"sense-making" discussions (by both students and teachers) to provide a glimpse at a prototype system that provides a new kind of instructional management appropriate to the internetworked school.

- Meril Smith will show how the "Classrooms for the 21st Century" project at Edenvale is designed so that an old school in a poor community can provide its students real access to technological tools typically only available to more affluent communities. He will also show how this National Information Infrastructure (NII) Roundtable prototype model of information age classrooms relates to redesign and restructuring efforts to re-create an entire district as an engaged community of lifelong learners.

These presentations will thus form the basis of four different "mini case studies" on how technology can be effectively integrated into systemic reform through bringing together the efforts of many existing "islands of educational innovation."

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Distance Learning (T3-306A)

One by Land, Two by Sea, Three by Modem

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Key words: distance learning, audio teleconferencing, computer conferencing, audiographics, videophone, video teleconferencing

Abstract

A variety of distance learning technologies will be described and demonstrated including:

- audio-teleconferencing
- computer conferencing
- audiographics
- videophone
- two-way video teleconferencing.

Participants will learn about hardware and cabling requirements, logistics of remote connections, and connect-time costs. They will participate in the actual demonstrations, talking with educators in remote locations. The technology will be placed in the hands of participants so that a number of them can actually experience making the connection, manipulating the camera, using the graphics tablet and document camera, etc.

Beyond just learning about the technology, participants will learn how various schools are using distance learning. A number of current programs they might have seen or heard about.

Finally, several key issues concerning methods of instruction, staff development, state and school policies, scheduling, needs assessment and evaluation will be discussed.

Special Session (T3-310A)

Networks and Collaborative Learning: Report From the "Alice" Testbeds

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Key words: testbeds, software, collaboration, inquiry, telecommunications

Abstract

The goal of the Alice/Collaborative Inquiry Testbeds project is to explore what elements–human and technical–are required so that large numbers of individuals , schools, scientists, and publishers can easily and inexpensively create and manage collaborative inquiry projects. These project typically utilize world-wide student collaborations that involve collecting, combining, distributing, analyzing, and discussing data. TERC's Testbeds project, currently in its pilot phase, is exploring the educational issues, organizational problems, technology tools needed to support teachers and network administrators, and required telecommunications infrastructure.

The model for networked curriculum that has been developed is based on the creation of a community that communicates in two ways: through E-mail messages and through shared data. The availability of shared data is key to the model. Students at each site collect their own set of data, then share their data through the Alice Network Software–an integrated suite of software tools designed for telecommunications and student analysis of data. Data is sent to a server by the various participants, and consolidated on the server so that students have access to the full set of data collected by all classes. The data set is then analyzed by the classes who are able to use E-mail messages to report their findings to each other.

The model creates a role for educational service providers–teachers, publishers like National Geographic Society, or commercial organizations that provide specific functions or support (e.g., technical support, scientists-on-line). These providers allow expertise to be developed and delivered inexpensively to large number of users.

Despite the potential of the model to bring the power of telecommunications to students and teachers in school settings, there are significant problems that must be solved. Curricula need to be carefully designed to make use of the power of students working remotely from each other, yet allow for the very different school calendars, local events, and even for different languages. Teachers and students will need support in the form of project automation software to assist them in organizing a project among many sites; the same is equally true of groups (such as state departments of education or organizations such as the Global SchoolNet Foundation) who might assume the responsibility for organizing and running such projects. Teachers will need a method to locate projects that are suitable for their classes without wading through screens full of E-mail messages.

Finally, the testbeds must prove themselves in the classroom with students and teachers. Do the new tools for working with, communicating, and consolidating data and the potential for distant collaborations justify the expense and support needed for telecommunications? We are confident that the answer will be affirmative, and are developing the approaches, the tools and the skills that will make it possible.

Project (T3-313A)

Interactive Video in the Middle School Music Appreciation Class

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Key words: hypermedia, music, interactive, multi-sensory, stimuli, middle school

Abstract

Hypermedia in the middle school music appreciation class provides an "electronic blackboard" for the teacher to use to engage students in the study of classical music. While many sources of information about classical music and the elements of music are available, a means of consolidating these segments facilitates the teaching process. Hypermedia, with its ability to access audio, video, data bse andpresentation formats, provides such a teaching resource.

The Three Styles of Music in Selections from *Fantasia* is a program authored using *HyperCard*© which provides the teacher with this coordinated format and provides the student with a variety of stimuli from which to construct knowledge structures. Rappaport in his text, *New Pathways to Art Music Listening* (1983. New York.), cites the abstract nature of classical music, the inaccessibility of classical music to the general population and the less primitive level of appeal of this music as contributing factors to the difficulty of teaching music appreciation. The Disney animation of the characters in the video, Fantasia, engages and entertains the learner while the teacher guides the learner through the themes and musical elements.

The program and lessons have been used with sixth grade music appreciation classes. The students' prior knowledge of music history included an ability to recognize timbre and a limitedunderstanding of rhythm, melody and tempo. Students were attentive to the video presentations of the compositions and looked forward to the next presentation.

Guided questions during group discussion and student worksheets encouraged the students to assimilate the information they observed and to form conclusions about the music. This guided discussion of musical elements kept the student attention focused on the music rather than solely on the animation. Thus, though the data base of information is knowledge level, students used higher order thinking skills in their analysis of the music under discussion. Continual use of the same format for each composition improved the students' ability to recognize the elements of the particular style.

The teaching/learning environment for which this program was written is one in which all participants, teacher and students, are actively involved\in the process of learning. Hypermedia aids this process by involving multi-sensory experiences for observation and assimilation.

Project (T3-313B)

Logo and Art: Artistic Imagination in the Technological Classroom

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Key words: Logo, LEGO logo, art, classroom, technology, science, math

Abstract

Our focus in education is veering away from recognizing and valuing the creative aspects of learning and the exercise of imagination in favor of science and math education geared towards producing testable results. In the preoccupation with getting the facts, the imaginative and creative aspects of schooling are being left by the wayside, yet there are interesting uses of Logo (and LEGO TC logo) which lean to the playful and imaginative while at the same time involving students in intellectual inquiry into uses of technology.

Many scientists will agree that much of their innovative work results from flashes of insight and use of their imagination as they develop new ideas and theories. The visionary scientist uses imagination as a catalyst for insights. These insights are often the starting points for many scientific and mathematical discoveries.

At the same time that funding for education is focusing heavily on mathematics and science, arts budgets are being cut. As educators we need to find ways to compensate for this. We need to seek out classroom activities that can provide enriching experiences with mathematics and science that have real-world connections and that also include experience with art.

By blending science and mathematics with art while using Logo or LEGO TC Logo, some innovative teachers have found ways to enhance student interest in the sciences while at the same time incorporating art education. Logo and LEGO TC logo projects have included architectural design, study of the work of artists whose architectural works display cast shadows, replication of traditional fabric designs of African or Native-American cultures, not to mention the study of optical illusions and kinetic art. Such approaches open new vistas for the scientifically inclined as well as the artistically inclined student. In the hands of gifted and committed teachers, projects of this sort expand the horizons of all students. Since they are based on the use of technology, the artistic side of these projects can "slip in through the back door," so to speak, affording a way to include art education in the curriculum without compromising a commitment to the study of math and science. In the final analysis, such projects are of benefit to everyone.

Project (T3-313C)

Interactive Multimedia Tools for Music in General Studies

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Key words: multimedia, music, interactive, CD-audio, videodisc

Abstract

The purpose of this interactive multimedia project is to exploit the capabilities of interactive multimedia technologies and bring to life traditional music appreciation lectures. Composer pictures, graphic outlines of works, live performances can be presented in a single system.

Traditional courses in Music in General Studies are often complicated by the need to present information in several different formats during a single class meeting (video, audio, graphics, animation etc.). All of these formats are currently available, but not in an integrated setting resulting in a somewhat chaotic presentation by the instructor. This program integrates all the media used by the instructor in a format controlled by computer for presentation.

The following integrated media can be available to the instructor/students in this type of system:

1. video, audio, computer graphics, animation, outlines;
2. multiple input sources from any of above;
3. networked computer system;
4. similar set-up in the media center (library) with bar-code capability.

This demonstration is the result of a 2-year-long grant to develop interactive materials for use in general courses in Western Art Music. The results of this program allow the instructor to use a variety of material in class; to easily alter the presentation; to add or delete material; and to use the material as a tutorial in the library for further student study. Original video and audio material has been integrated into the computer presentation which enhances the concepts presented to the class. The students are presented with the finest performances available (and to the instructor's favorites) without leaving the classroom. The instructor is free to move about without being tied to a lectern and can instantly recall material from the current lecture or a previous one (or even a future one) without the use of the blackboard. Once the instructor has familiarized himself/herself with the method of presentation, other courses can be adapted to this method very easily.

This program allows the instructor to design his/her own lesson plan using virtually any source material. Study guides for the students can be made available on a floppy disk for printing at the student's convenience. All lectures and examples can be recalled instantly and introduced during the lecture simply through the use of bar codes. This lecture-demonstration presents the state-of-the-art music classroom as used at Virginia Polytechnic Institute and State University.

Spotlight Session (T4-BRBA)

Students and Teachers are Building the Information Highway to the Land Where Learning and Schooling are Different than Before

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Key words: networking, information infrastructure, educational reform, educational policies, telecommunications, distance learning, networking testbeds

Abstract

A recent popular song asks, "If we build a road, will it take us where we want to go?" In this session, we will take a look at the work of learners and teachers in building the Information Highway. Many reforms sought in education are exemplified in the activities of learners, teachers and experts in networked communities, both local and virtual. A growing number of students, teachers, and educational administrators, as well as people outside of formal educational institutions, are not only advancing their own education but are also contributing to each others' learning and to the knowledge base in cyberspace. Invention and sharing of know-how proceeds rapidly along the newly constructed roadways.

Will it take us where we want to go? We will examine some alternative "places" our new roads could take us. Educational opportunities for all could not only increase but be very different from today, as more people and institutions participate and invent new roles as producers of knowledge. If services and applications develop in ways that help many people add value to the information infrastructure, we can foresee a renaissance of mind, spirit, and society for everyone. Some principles for policy, finance, architecture, tools, and implementation such as common carrier, open architecture, interoperability, and user constructability, can lead in a direction of greater creativity, collaboration, entrepreneurship, and equity.

Unfortunately, not all possible scenarios are attractive. The public policies, regulatory frameworks, ownership models, and technological infrastructures now emerging will dramatically shape the landscape we find ourselves in ten years from now. We have a window of opportunity for educational reformers to have a voice in the decisions that are driving the direction of these "highways of the mind."

Paper (T4-201A)

Object-Oriented Programming in High Schools the Turing Way

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Key words: teaching programming, object-oriented programming, computer science education, inheritance, teaching unit, Turing

Abstract

This paper proposes an approach to introduce object-oriented concepts to high school students using the Object-Oriented Turing language. The students learn about the concepts of objects, classes and inheritance by using and expanding a collection of classes that draw pictures such as circles and happy faces. Materials for a two-week teaching unit have been developed to support this approach.

Introduction

There is a race to develop new software to meet the ever increasing capacity of hardware. Hardware capacity, in terms of both speed and memory, continues to double approximately every two years. Those individuals and countries with the expertise to develop such software have the potential to realize great technological and economic gains.

This continuing demand for software requires new methods of development that help solve the central problem of software creation. The basis of the problem lies in the inherently complex nature of software. What is needed are methods that help us better understand and control the software being developed. The advent of structured programming some years ago was a large step in the direction of controlling this complexity. Object oriented (OO) programming now promises similar gains, because it divides software into distinct parts, called "objects" which communicate only in rigidly specified ways.

After reviewing the key principles of object oriented programming that our students should learn, this paper discusses the Object-Oriented Turing system, which was developed to support the teaching of programming and software engineering. Next comes a discussion of the use of this system in teaching OO ideas across a university curriculum. Finally, the paper presents experience using of the system with high school students and suggests how the system may be useful in high school Computer Science courses.

Principles of OO that We Should Teach

In this section, we will cover the key OO principles [Cox 87, Booch 91, Budd 91, Meyer 88] that a student should learn. It should be emphasized that the ideas of object orientation reach well beyond computer programming. Indeed, we should think of the OO approach as a method of problem solving [Yoder 1993], which applies well to programming.

Three Foundational OO Concepts: Objects, Classes and Inheritance

Objects

The first and most important concept in OO is called information hiding. Long before OO became popular, this concept was recognized as the "black box" principle. A black box is an item, such as a radio, that is understood in terms of its inputs and outputs and not by its internal construction. For the radio, its buttons and knobs characterize its input and the sound it produces characterizes its output. In OO terminology we refer to a black box as an "object". In terms of software, the essence of an object or black box is that we hide data (and other internal implementation details) in a "box" and all that we can manipulate or observe from the outside is the externally visible interface, mainly the exported subprograms (these are called ***methods***). OO languages provide syntactic mechanisms to enforce this hiding.

Classes

The second foundational concept in OO is the idea of a "class". A "class" of objects is a set of objects all of which are the same, or sufficiently the same for our purposes. From a programming point of view, a class is a template from which we can ***instantiate*** or replicate objects. Using our previous example, a class can be thought of as the design of a radio, from which we can make many individual radios. In large software systems, we make constant use of software objects, such as files and windows, which are (or are essentially) instances of classes. To make the concept of classes clear to the student, we need exercises that use many objects. The book ***An Introduction to Object-Oriented Programming*** [Budd 91] gives a good example of the use of objects, namely, a program that supports the game of solitaire using a class of playing cards and a class of stacks of card .

Inheritance

The third key OO concept is called "inheritance". Class D ***inherits*** from class C if class D contains all the items of interest that C contains. For example, consider a new radio design D, that is just like an old design C, except D adds a new knob that activates a new external plug for ear phones. In this case, we say D inherits from C. We say D ***is a*** C, meaning that we can use a radio of design D for all the same purposes for which we can use a radio of design C.

There are actually two ways in which an inheriting class D can be different from its parent class C. First, it can extend or add to the parent class. For example, a new subprogram or data field can be added. Second, it can change or *override* certain kinds of items in the parent. The power button on the radio might be changed (overridden) to turn on a light on the radio, as well as turning on the internal circuits.

Overriding allows us to create similar but significantly different objects. For example, all objects that are Macintosh files have much in common, but the effect of opening a particular file depends on the kind of file we open. For example, opening a *HyperCard* file is quite different from opening a Word Perfect file. This is because the open operation has been effectively overridden for the various kinds of files. We say that Macintosh files are *polymorphic* because they react in varying ways to the same operations.

These are the three basic concepts of OO (objects, classes and inheritance). In this discussion we have used the metaphor of a radio and its design. We now turn to diagrammatic conventions for representing OO concepts.

Diagrams and Relations

There are a number of important relationships among objects and classes, and these are best understood using diagrammatic conventions. At the level of objects (instances), the two key relations are *has a* and *uses*. Figure 1 gives a diagram of an Account Manager object and a Check Book object. The arrow from the Account Manager to the Check Book indicates that the Account Manager "uses" (calls) the Check Book. The Check Book object "has a" (contains) internal variables (a ledger, which is an array of records that keep track of checks and withdrawals) and two externally visible subprograms (Write Check and Make Withdrawal). The protrusion of Write Check and Make Withdrawal from Check Book indicates that they are visible outside of Check Book. To keep the diagram simple, we do not show the items contained in the Account Manager.

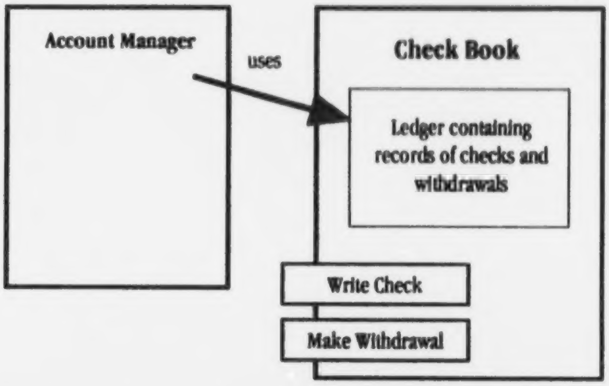

Figure 1. Example of diagrammatic conventions for objects, showing the "uses" relation and the "has a" relation.

Among classes, the most important relation is "inherits", as illustrated in Figure 2, which shows that radio design D inherits from radio design C. Another essential relation is "instance of". For example, a particular radio object R, might be an instance of radio class D.

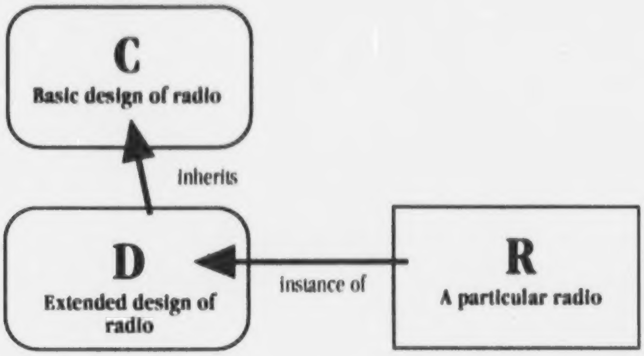

Figure 2. Diagrammatic convention for classes and objects, showing the "inherits" and "instance of" relations. Rectangular boxes are objects. Rounded boxes are classes.

Students will understand OO ideas much better when they have mastered these diagrammatic techniques. (There are many diagrammatic conventions; the details of the one used for teaching are not important.) A student should be able to visualize a given program's structure in terms of these diagrams and conversely, be able to create a program that has been designed using these diagrams.

The reason these diagrams are so useful for learning, is that they use our visual sensibilities to represent a rich set of ideas. These ideas include the relations of "has a", "uses", "is a", and "instance of" among objects and classes. These diagrams concentrate on the software's structure, allowing us to suppress implementation detail to better understand program design.

Software Development Environments

One of the most important ideas emerging from the Smalltalk language is that a programming environment, based on appropriate principles, can significantly improve the way we program. A Smalltalk environment includes on-line libraries. We can *browse* through these libraries of re-usable classes and experiment with them with great facility. Largely because of this, Smalltalk encourages rapid prototyping to a degree that has not been approached in most languages. Turbo (Borland) environments for Pascal and C++ provide integrated environments that expedite the edit-compile-link-debug cycle. Compared with those environments, the Smalltalk environment has the advantage of supporting larger scale programming, in which off-the-shelf components can be assembled into new programs.

Missing from both Smalltalk and Turbo environments are tools that are commonly called CASE (Computer Aided Software Engineering) facilities. These tools provide machine assistance for the diagrammatic approach that we have just discussed. The student's learning can be greatly advanced if these tools are available in an integrated environment, which ideally can generate diagrams from software, can generate skeletal software from diagrams, and can check that the diagrams and software are consistent. The OOT environment, which is described below, provides both diagrammatic capability and on-line re-use libraries.

Software development environments (SDEs), as exemplified by Smalltalk, support a method of software creation that is inherently faster and better than is possible using older paradigms. Those paradigms were limited to collections of tools such as editors, compilers, linkers, and debuggers.

It is clear that the fundamental concepts of OO are closely related to ideas such as diagrammatic conventions, software development environments and software re-use. We will now discuss OOT, which is a language and environment suitable for teaching OO ideas.

The OOT Language and Environment

The C++ and Smalltalk languages are perhaps the most commonly mentioned languages for supporting the teaching of OO concepts. Other languages which are good candidates for teaching OO concepts include Objective C, Turbo Pascal with OO extensions, Eiffel, Modula 3, and CLOS. We will not discuss these languages in any detail, but refer the reader to discussions of OO languages appearing in the literature [Budd 91, Booch 91]. In this section we will give an overview of the Object-Oriented Turing language and software development system.

The OOT software development environment was designed for use in teaching. It has evolved from the Turing language [Holt 88] which is a Pascal-like language that is very easy to learn. Turing is now used in 30 universities and in half of the high schools (about 400 schools) in the Province of Ontario, where it is used on PCs and Macintoshes. The Turing implementation used in high schools provides an integrated edit-compile-run system. OOT extends the basic Turing system by providing more advanced programming features, including OO features, and a sophisticated software development environment. The OOT environment, up to now, has been used on Unix systems including SUNs, SGIs and IBM RS-6000's. A version that runs on PCs under MS-Windows is expected to be available in Summer 1994. The OOT language and its SDE have been described elsewhere [Mancoridis 92, Holt 92], so we shall only give an overview here. (See the Appendix for the way to access the FTP on-line Unix demonstration of OOT.)

With the advent of windowing systems, such as MicroSoft Windows for PCs, our students should be aware of the ways in which windowing facilitates programming. In the case of the OOT SDE, individual windows encapsulate the distinct ideas that the programmer deals with. For example, each source program object, such as the Account Manager in Figure 1, is displayed in its own window. There are also windows to show the program's output and to show error messages.

Perhaps OOT's most striking use of windows is the Landscape Window. This window displays a diagram (called the Landscape) with boxes representing the objects and classes in the program. For example, a Landscape view might show a picture much like Figure 1 for the corresponding program. There is a "hot link" that allows the user to immediately access the source code that corresponds to each box in the diagram.

Another window gives the Process Dump, which is a stack trace of called procedures that can be used to locate the current line of execution. There are also windows, called Interface Views, that give the interfaces for objects such as the Account Manager object (Figure 1). These Interface Views, which are automatically created from the source programs, allow the programmer to inspect the entry points (methods) of an object along with corresponding parameter types and comments. Double clicking on the name of a method in an Interface View causes the corresponding source code to pop up in a window.

OOT displays the current directory in a window, much as does a Macintosh. Double clicking on a name in this Viewer causes a fresh window to be popped up. This new window shows the file's contents. The Directory Viewer serves as a browser for inspecting objects and classes, as well as for the on-line language reference manual and for re-use libraries.

Our purpose here is not to describe OOT in any detail [Holt 92] but rather clarify how much its facilities may be of help in teaching programming and Computer Science concepts.

OOT in an Undergraduate Curriculum

This section discusses the use of OOT [Holt 1993] to introduce object-oriented concepts across the undergraduate curriculum [Temte 91, Reid 92]. The following section will focus on use of OOT with high school students.

At the University of Toronto, OOT is used in many courses, including courses on data structures, courses on compilers and courses on operating systems. We will concentrate here on those courses which have used OOT explicitly for teaching object-oriented concepts. In particular, we will discuss our use of OOT for teaching these concepts in (1) an introductory programming course, (2) a course on programming paradigms and (3) a course on software engineering.

Since Fall 1992, the OOT software development environment has been used in the University of Toronto introductory classes in the Faculty of Applied Science and Engineering. These classes have followed a fairly traditional approach to introductory computing at the university level, with emphasis on general computing concepts such as data structuring, operating systems and networks as well as programming proper. For the first time, in Fall 1993, a unit in one of these classes is concentrating on object-orientation, with the goal of making students aware of the concepts of objects, classes and inheritance. The students are required to complete a graphics-based assignment (much like the one described below for the use in high schools).

When these students are first introduced to OOT, they use only simple features, including a window containing their program, an output window and the Directory Viewer.

OOT has been designed to be very easy for the novice to use [Milbrandt 1991]. The student begins, with little explicit instruction, by using OOT's mouse-based Macintosh-like interface. The Turing language's simple input/output and graphics statements allow students to begin writing programs immediately. For example, here is a complete program that outputs "Hello world" and draws a green box on the screen with opposite corner coordinates at (10, 15) and (100, 120).

```
put "Hello world"
drawbox (10, 15, 100, 120, Green)
```

The OOT system has a pay-as-you-play philosophy that allows students to learn more of the system as they master more concepts. Only after the fundamentals of programming, including loops, arrays and subprograms, have been taught, are OO concepts introduced.

Like many Computer Science departments, ours offers a course on programming paradigms, which is given in the third year. Our course is actually titled Principles of Programming Languages, but its real purpose is to acquaint students with paradigms such as logic programming (PROLOG), functional programming (LISP), concurrency, and so on.

In a 4-week unit in this course, we use OOT to teach the OO paradigm. This unit has as its goal to teach design implications of OO, at a much deeper level than is possible in an introductory course. By the time our students reach this course, they have had considerable experience with Turing, though not generally its OO features, so little time is wasted instructing them about syntactic issues of OOT. Although other languages, such as C++, are mentioned in the unit, only OOT is covered in any depth. The students' assignments are based on an existing class-intensive program called Star, which reads OOT programs and automatically creates diagrams on the screen for them that are analogous to Figure 2. The students are required to enhance this program in various ways, for example, so it outputs PROLOG facts corresponding to the relations among the OOT program's classes. This work exposes students to many issues of importance to software engineering, including automatic program diagramming, program maintenance, and multiple views of a program, all within an OO context.

A fourth year University of Toronto course provides a standard coverage of software engineering concepts [Sommerville 92]. This course uses an OO approach in the following way. At the beginning of the course, the students are given a set of milestones representing the phases in the life cycle of a software "product" that teams of three students in the course are required to create. The product last year was a Graphical User Interface (GUI) library written in OOT targeted for use by other undergraduates. Ideally, the product would be used by other classes of students to allow them to incorporate GUI support (menus, buttons, etc.) as a part of their programs.

The hardest part of the project was the design phase, namely, deciding upon the class hierarchy for user interface objects. The goal was to provide an interesting exercise in software design, something that is too often missing in undergraduate education. This project was intended to teach many software engineering concepts including the software life cycle, team work, delivery of re-usable software, etc., all in a modern OO environment, namely OOT.

This short discussion of use of OOT at the University of Toronto has been intended to illustrate how the teaching of OO concepts is being introduced at the university level. We now turn to the question of teaching these concepts in high schools [McGregor 1992, Stephenson 1992, Funkhouser 1993].

OOT at the High School Level

Each summer the Department of Computer Science at the University of Toronto teaches a short summer course to selected high school students on principles of Computer Science. Last summer 62 students participated in this intensive 3-week course.

For the last two summers, these students have been introduced to OO concepts, in a unit in this summer course, in the following way. First the students practice the fundamentals of programming: loops, IFs, subprograms and simple data structures, as well as simple graphics. Then, they are exposed to OO concepts (objects, classes, and inheritance) by means of an assignment based on a simple class library for drawing figures. This library (see Figure 3) consists of a tree of classes.

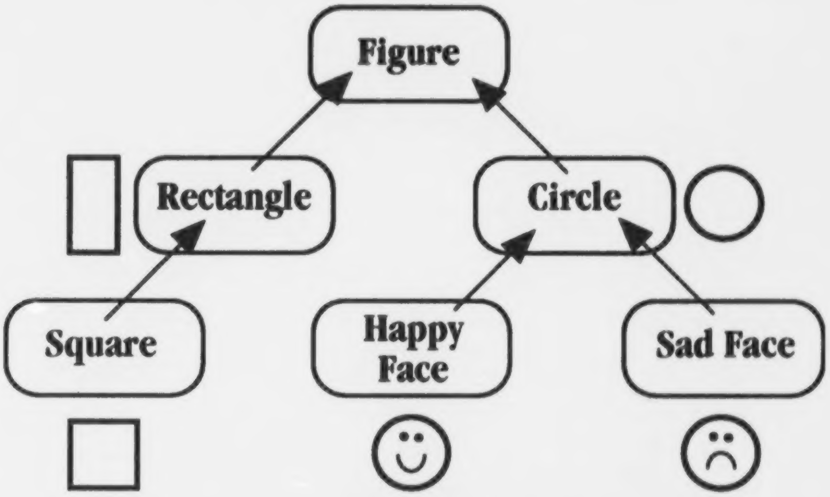

Figure 3. A class hierarchy used for introducing students to OO concepts. The arrows show inheritance.

The root of the class tree is called Figure. It represents objects that can, in principle, be drawn on the screen and later erased. The actual bodies for the draw and erase procedures of the Figure class are omitted. In other words, Figure is an "abstract" (or "virtual") class that represents all objects that can be drawn and erased, but does not represent any particular figure. Classes such as Rectangle and Circle, which descend from (inherit from) the Figure class, provide actual code to draw and erase particular figures. (In the actual assignment, there is also code to set the color, size and position of figures, but these details will be ignored in this paper.)

The students are provided with a library that implements the hierarchy shown in Figure 3, but without the HappyFace and SadFace classes. The students are required to enhance the library with the missing classes and to have their program draw an interesting scene on the screen using these classes.

Since the assignment is so graphical, it is easily explained to students. They are clearly pleased with the results of their work, which displays a picture on the screen. The objective of this exercise is to give introductory students a good feel for OO concepts, including use of libraries and SDEs.

This experience with high school students suggests that teaching object-orientation at the high school level, using software support such as that provided by OOT, is straightforward and can be quite rewarding to the students. The approach assumes an initial introduction to fundamental programming ideas and follows immediately with OO ideas. The emphasis on graphics makes the work exciting to the students and makes the ideas much easier to grasp.

Using the experience from these courses, the author has developed a two-week OO teaching unit for use in high schools. The unit is supported by a 19 page hand out for the students, which includes exercises. Each concept is first introduced at the "everyday level", that is, in terms of familiar objects such as radios. Then the students are introduced to the corresponding OO concept at the level of programming. The students use a collection of classes, similar to the collection described here, to gain experience with actual OO programming, using the Object-Oriented Turing system. The student should have experience with a programming language such as Pascal, C or Basic and a familiarity with procedures before covering this unit. The Appendix tells how to access this teaching material and software.

The state of the art in computer software is constantly changing [Stephenson 1990]. We should not be surprised that there are new ideas, such as OO concepts, that need to be introduced into our schools. The design of Computer Science curricula for high schools [Merrit 1993] is a never ending job, repeatedly introducing new concepts when they are seen to be intellectually interesting and industrially justified. It seems clear that OO concepts have now reached this stage, and it is only a question of how, not whether to introduce these ideas into our schools. The good news is that OO concepts can be nicely integrated with high school Computer Science teaching without a great deal of change in the approaches we have already been using.

Conclusions

This paper suggests that, given an appropriate software development environment such as OOT, sophisticated OO ideas can and should be taught at the high school level. A radical change is not required in teaching programming fundamentals. Instead, once the fundamentals are introduced, a new direction, the OO direction, is followed in a natural and rewarding way.

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Appendix: Access to Teaching Unit and OOT Software

A copy of the two-week unit for teaching OO concepts is available from the author. A demonstration version of the Object-Oriented Turing system for MicroSoft Windows can also be requested. This version comes with the collection of classes used in the teaching unit.

For those people with access to Unix, there is an on-line demonstration version of Unix OOT from the University of Toronto that can be accessed by anonymous FTP (File Transfer Protocol). The OOT environment has been implemented on various Unix platforms, such as Sun/4's, RS/6000 and SGI. If you have access to the Internet and Unix, you can get instructions to access the demo by these commands on Unix:

```
%ftp 128.100.1.192
ftp> cd pub
ftp> get ootDistrib
ftp> quit
```

The ootDistrib file in your directory will now contain details on getting the demo.

Paper (T4-201B)

Abstraction To Implementation: A Two Stage Introduction To Computer Science

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Abstract

A novel three semester core curriculum for undergraduate Computer Science is described. It addresses the problem of effectively presenting both abstraction and implementation. Both functional and imperative programming styles are taught. Two courses in the first semester emphasize abstraction. The next course stresses implementation as well as analysis. The third semester provides practical experience in programming in the large.

Introduction

The last decade saw a major change in undergraduate foundations courses in Computer Science. Microcomputers and efficient Pascal compilers encouraged a standardization of introductory courses. Although other languages remained popular, Pascal became the standard as evidenced by the emphasis placed on its mastery in the Advanced Placement Exams and the plethora of Pascal textbooks. Yet many of the problems that the designers of Pascal attempted to address remain. Some students still fail to grasp underlying computer science concepts or develop strong programming skills (Koffman, Stemple, and Wardle, 1985).

In order to become proficient programmers, students must develop strong theoretical foundations as well as a firm grasp of how those concepts can be implemented on a modern computer. We claim that most current curricula muddle abstraction and implementation, diminishing students' ability to master either. Too often students learn an abstract concept as they learn to implement it in Pascal. Linked lists implemented with pointers is an example. Students fail to appreciate list structures because they never fully gain mastery of pointers. The approach described in this paper presents abstractions before implementations.

Two movements are currently encouraging the abandonment of Pascal as the language for introductory Computer Science (Decker & Hirshfeld, 1993; Roberts, 1993; Skubles & White, 1991). The "abstractionists" advocate functional (via Scheme) and object-oriented paradigms to stress concept over syntactic minutia. The "pragmatists" advocate C as a practical choice for "real world" programming. We take a middle ground in which both Scheme and C are introduced within the first year. We also expose students to object-oriented paradigms so that "programming in the large" can be addressed via C++ and CASE tools in the third semester.

Our goal is not only to make our students literate in two divergent paradigms. We explicitly focus on the dichotomy of abstraction and implementation. Scheme is used to introduce the "big ideas" of Computer Science in the first semester in "Computational Problem Solving" (CS1). This course is strongly articulated with a concurrent mathematics course, "Discrete Structures of Computer Science" (DS) that replaces the classic Discrete Mathematics course and also uses Scheme. The Scheme environment allows us to avoid the syntactic detail required in Pascal or C environments. The practical problem of implementation is addressed in the second semester in "Implementation and Analysis of Abstract Data Types" (CS2) ,when C and C++ are used to examine how abstractions are expressed efficiently. In the third semester "Programming in the Large" (CS3) provides experience in applying implementations of abstractions to large complex problems.

This curriculum has innovative aspects with respect to organization, methodology, and content. By integrating programming with mathematics in the first semester, abstractions and implementation become partners rather than competitors. In the later courses implementation and analysis can be emphasized more naturally because of the early mastery of abstractions. The methodology emphasizes active learning via concrete laboratory experiences, extending even to coverage of theoretical concepts in DS. Finally, the content is unusual because it includes the mathematical concepts underlying modern programming methodologies, introduces multiple languages within the first year, leads gracefully toward programming in the large, and presents the object-oriented paradigm throughout.

Each of the courses will be described in detail. A summary of our results to date is then provided.

Discrete Structures of Computer Science (DS)

The goal of DS is to present aspects of mathematics that relate to problem solving by computer so that students can apply them in diverse contexts. The content of DS is innovative because it places particular emphasis on those topics that relate closely to modern programming concepts, while the standard discrete mathematics course covers a more diffuse collection of topics. For example, we believe that lists, trees, and word algebras should be given the same early emphasis as sets. Laboratory work is included to foster exploration of concrete examples.

Several alternatives to the mainstream discrete mathematics course have recently been proposed. Henderson (1990) argues for a primary emphasis on problem solving, supported by appropriate laboratory experience. Maurer and Ralston (1991) minimize mathematical formalism and center on algorithms and problem solving via induction and recursion. Neff (1993) has supplemented the topics of the traditional course with laboratory experience using a complete logic programming system with Prolog syntax.

We attack the problem of non transferability of discrete mathematics through two mutually reinforcing, concurrent courses (DS and CS1) covering foundational topics in algorithm design, programming, and discrete structures, under the unifying principle of problem solving. We reinforce each important concept through appropriate laboratory experience. Freshmen are capable of understanding complex concepts and relationships, but often lack the motivation necessary for following formal textbook mathematics. The new DS course uses a strategy of involvement by example, via declarative programming.

Features of our new DS course include:

1. A small set of mathematical topics, closely related to the core of computer science covered in depth. Topics include: functions on lists, trees, and word algebras, the relational database model, polymorphic type inference, decompositions of digraphs, and formal languages. Each topic is presented as an application of general foundational principles, such as recursively defined sets and functions, structural and numerical induction, properties of relations, and informal predicate logic.
2. Concrete examples are explored both through paper and pencil exercises and laboratory work in Scheme and with specific software packages for abstract mathematics, such as ISETL. Articulation with CS1 is critical to insure that programming concepts are mastered before being applied to mathematical abstractions.
3. Work in logic programming utilizes a specially developed language known as Prologb (Neff, 1993). It implements a pure logic subset of the Prolog syntax, and, unlike Prolog, uses a breadth-first search strategy to guarantee solution for all valid queries, regardless of the ordering of clauses or goals.

Computational Problem Solving (CS1)

A first course in Computer Science should introduce the fundamental concepts of the field, and provide a strong foundation in the practical art of programming (ACM Curriculum Committee, 1991). There is conflict between teaching the abstract concepts and providing a practical experience upon which later courses rely. Our innovative approach is to introduce abstractions of all kinds (including OOP) in CS1 using a language such as Scheme that is suited to "hiding" implementation. The emphasis in our CS1 is not on functional programming per se. We exploit the high level nature of a functional language in order to avoid low level syntactic minutia.

The classic approach to introductory programming assumes that students must first learn the "primitive" constructs of a programming language before proceeding to the more abstract. For example, pointers are taught before lists. It is an historical artifact that data types such as lists and graphs are not considered primitive data types within a language like Pascal. Such limitations are creating an accelerating shift away from Pascal. For example, Roberts (1993) found Pascal inadequate as a base for teaching modern programming concepts, overly restrictive in design, and of limited usefulness in more advanced work, and opted instead for C. Skubles and White (1991) chose Smalltalk in order to stress modular design and reusability. Decker and Hirshfeld (1993) teach the object-oriented approach via Object Pascal.

We believe a first course must emphasize the fundamentals of programming, including iteration, recursion, decision making, data encapsulation, and process control and modularization, rather than the mastery of the details of a particular programming language. We emphasize the fundamentals through three means. First, CS1 itself provides an abstract conceptual framework through formal lecture and off-computer problem solving activities. Second, the course is articulated with DS so that the strong ties between the mathematical formalisms and the computational expression of those formalisms is

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made clear to students. Finally, extensive experience in developing solutions to small programs is provided in both open and closed laboratory activities. Closed laboratory sessions provide invaluable guidance in important working strategies such as program organization, incremental testing, and use of the debugger.

Our current choice of language is Scheme. It allows us to dispense with much of the syntactic minutia associated with Pascal (or C) because of the absence of required data typing, the simple syntactic form, and the more natural expressibility of functions as individual entities via an interpreted environment.

A major theme is the practical illustration of top-down design via bottom-up implementation. The functional paradigm is used to stress the components of a computational process: input (via parameters), output (the returned value), and process (the body of the code.) Small programs (functions) can be designed, coded, tested and debugged as autonomous units. Once verified they can be combined into larger procedures, which themselves eventually form a fully working program. In essence, this is bottom-up implementation.

The stumbling block in many introductory computer science courses is convincing students that bottom-up implementation alone is not sufficient. Top-down design must precede it. The contribution of a discrete structures course is critical. By viewing a solution to a computational process as a static function, rather than an imperative process, students are encouraged to think of the composing function and its parts, regardless of how the details of the parts are constructed. We believe this will lead to a perspective in which top-down design is viewed as a natural evolution, rather than a form that is required by the instructor.

Features of CS1 include:

1. The course begins with the concept of a function. Both primitive and user defined functions are used to construct larger solutions to simple problems. Correctness is stressed by showing the correspondence between the informal denotational semantics of Scheme and the model of the problem.

2. Program control is introduced via recursion and conditional branching. The emphasis is on a strong association with a mathematical (and thus declarative) specification of a solution to a problem.

3. Data organization and typing are introduced via the use of nested list structures. Data types (integers, reals, Booleans, strings) as specializations of the concept of a symbol are presented. Data abstraction (including stacks, queues and trees) is shown to be an extension of nested list structures. Object-oriented ideas are shown by stressing operator definitions such as constructor and accessor functions and by showing that functions are first class objects.

4. The imperative framework is introduced. The iterative construct is presented together with an explanation of its correct use. Iteration is shown in relation to recursion; the recursion's precondition is precisely the loop invariant. Arrays (vectors) are presented within the context of efficiency of access. I/O is initially introduced via a discussion of the read/eval/print loop as a means of creating customized environments. More traditional perspectives on interfaces are then discussed and simple file processing is introduced.

Implementation and Analysis of Abstract Data Types (CS2)

The goal of CS2 is to provide insight into the implementation and efficiency of the structures and algorithms that were learned in CS1. A model of computation that is close to that of the actual hardware is required; hence an imperative framework is critical. The goal of CS2 is not to teach an imperative language, but to emphasize the analysis of the trade-offs between implementations. Within this context, the notion of efficiency, both of time and space, has special relevance. The major innovation of this course is that it is not simply an extension of CS1, but explicitly changes the focus from mastery of abstract concepts to analysis of implementation and efficiency. This approach is exactly the opposite of the traditional curriculum.

The traditional CS2 course is the place where the price is paid for any flaws in CS1. In the last decade, the curriculum has collapsed downward, and CS2 typically emphasizes intermediate programming, data structures and algorithm analysis, as well as software engineering. If the CS1 experience was in the "Pascal language features" form, students do not have requisite skills to master all of this new material. When the CS1 course excessively emphasizes low-level details, students lack experience in procedural organization of medium-sized programs. When discrete mathematics is not integrated with CS1, they do not have the requisite mathematical maturity to absorb algorithm analysis.

Many current CS2 books present data structures and algorithms in a cookbook fashion. When the "classic" algorithms and data structures are presented as complete Pascal code, there is little incentive for the instructor or student to go beyond the study of completed solutions. Such approaches de-emphasize trade-offs between solutions. Similarly, algorithm analysis is often lost on students because they are shown techniques for polynomial time, but not logarithmic or exponential time, even though the trade-offs between the three is the real point of the discussion. The polynomial techniques are often learned by rote and consequently do not help develop intuitions about time complexity.

Our approach is to emphasize implementation and analysis over the simple mastery of data structures and classic algorithms. The difference is significant. In our CS1 and DS students will have been exposed to the "big ideas" of algorithm design and data structure choice. They should be comfortable users of abstract data structures. Since the concepts and mathematics have been covered, CS2 can efficiently focus on the imperative implementation of those concepts. Teaching the imperative framework is critical, not as a second approach to programming but as an introduction to the traditional processor. The emphasis requires exposure to an imperative language with object-oriented extensions. We have therefore chosen to introduce both C and C++.

Features of CS2 include:

1. Introduction to the features of an imperative language compared with those of a functional language (sequential nature of code, relationship between procedures, parameter passing, structure of a complete program).
2. Discussion of implementations of abstract data types in a strongly typed imperative language (e.g. stacks, queues, linked lists, trees) as both static and dynamic based implementations. The focus is on analysis of trade-offs: for example between static and dynamic implementations.
3. The object-oriented paradigm is introduced with an emphasis on implementation and efficiency both in reduction of coding time and transferability to other problems.

Programming in the Large (CS3)

The goal of CS3 is to provide students with real experience in solving large complex "real world" problems. The focus is the design, management, production, documentation and maintenance of large software systems. It strives to extend the notions of encapsulation, data and procedural abstraction, and inheritance by building on the students' prior experiences with the object-oriented paradigm. This course is innovative in its reliance on the previous mastery of abstract concepts, allowing management and implementation of a large problem solution to be emphasized without imposing huge time commitments from students.

The common requirements of ACM Curricula (1991) includes unit "SE2: The software development process", which covers life-cycle models, design objectives, documentation, configuration management and control, reliability issues, maintenance, specification tools, and implementation tools. Surprisingly, object-oriented technology is not listed among the topics within the ACM's topics for software engineering or advanced software engineering, although it is mentioned in some of the sample outlines for workshop courses.

Both the industrial and research communities recognize that OOP is an emerging technology (Osborne & Johnson, 1993; Skubles & White, 1991). The problems recognized in attempting to teach students the object-oriented paradigm via hybrid languages like C++ are great enough to require that their first exposure be through a high level language supporting full OOP. We believe that within a few years, experience with object-oriented technology as well as formal study of large-scale programming will be considered essential for computer science professionals.

CS3 builds on the early curriculum to produce an exceptional exposure to the areas of software engineering and the object-oriented paradigm. The course is taught on Sun workstations and emploies the vast array of tools available in UNIX, such as SCCS, RSC for version control, XView for windowing, and SunWorks for software development. The object-oriented features of C++ are used extensively.

The course builds extensively on the experiences of the previous courses. In CS1 data and procedural abstraction, information hiding and inheritances will have been introduced. The object-oriented paradigm will have been continued throughout CS2 through Scheme, as well as C++. In CS3, Scheme will still be used to demonstrate and motivate and C++ will be the vehicle to achieve the results in a "real-world" language. The use of Scheme as a motivator/facilitator in CS3 is similar to that of the course described by Kay (1992). However, our approach is radically different in that we employ Scheme in the first course to implement concepts fundamental to computer science (where he uses Pascal). We move from the functional paradigm to the procedural one of C and C++ in CS2 (where he continues the procedural through C and introduces the functional through Scheme).

Another feature of this course is team projects. We address the pitfalls of team projects described by Pournaghshband (1990) by limiting team size, making the projects interesting and useful and requiring walkthroughs. CS3 also relies on a required lab experience. The labs will be used for the demonstration and development of modules that will become component parts of a "large" software system. In some cases, needed components will be available in project libraries. Software engineering tools is demonstrated..

Features of CS3 include:

1. The course begins with a review and extension of prior OOP experiences through solution design using a true object-oriented variant of Scheme followed by re-implementation in C++. Comparisons between solutions are made.
2. Students are introduced to software engineering concepts through formal lectures and closed lab. A problem situation will be presented and student teams will design, code, test and document a large software system to completely or partially solve the problem. Topics include: software development life cycle, walkthroughs, software tools and environment, requirements specification, design—structure charts, testing, and maintenance.
3. The required laboratory component of the course will involve producing small modules that serve as building blocks for a large software system. This lab experience will also provide demonstration and training on software engineering tools.
4. Activities centered on code reuse and the advantages of OOP in this process will be stressed through lab activities and required in the design and implementation of each team's project.

Summary and Status

Versions of CS1, CS2 and DS that led to the curricular detail described here were offered between Summer 92 and Spring 93. In Fall 93 fully articulated CS1/DS courses were offered for computer science majors. In Spring 94 the new CS2 was offered for these students. CS3 will be offered in Fall 94.

To date, we have seen a marked improvement in performance among students in the new DS, CS1/CS2 sequence. They demonstrated the ability to articulate a problem solution both in English and in Scheme. Quick mastery of a second programming language occurred in CS2, but more significantly, students employed a programming style based on the procedural emphasis from their experience with Scheme. We believe this resulted from a firmer grasp of the abstractions, and because we could separate the abstractions from the implementation. Our results to date have been informal and anecdotal. Course notes and laboratory exercises have been prepared, and are being formally tested and evaluated during the 93-94 academic year.

We expect that the new courses will contribute to a redefinition of the objectives of the initial core courses in computing and supporting mathematics. In mathematics, we moved from a "grab bag" of isolated topics to a package of concepts particularly useful and concurrently applied to computer science. In computing, we moved from courses with syntax-centered emphasis to ones focused on the application of theory and high level computing concepts to problem solving.

Because of the superior theoretical background provided by DS, CS1, and CS2 we are able to more successfully meet objectives. The potential impact of the new DS, CS1, CS2 and CS3 sequence is to demonstrate a teaching methodology that provides students with strong conceptual foundations, while simultaneously providing practical experience in developing efficient implementations of those concepts.

Acknowledgments

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Paper (T4-202A)

Integrating PC Tools for Presenting Information in Science Classes

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Key words: science, writing, PC-tools, integration, spreadsheet

Abstract

There are a variety of computing tools available for students in educational institutions. With knowledge of standard tools, and how they can be used to compliment one another, one can gain some impressive skills for presenting information. This paper demonstrates a method for science students to use in preparing data for analysis and dissemination. It also informs about the integrative nature of the tools. The sample project demonstrates the use of a wordprocessor and spreadsheet.

Introduction

Computer science and information system students routinely work with computer tools in a majority of their classes and learn how to apply those tools in the process of completing a project. Other science students, however, are often barely computer literate and have not learned how to utilize common computer tools to the extent possible. In most science classes students are required to generate data, present it in a meaningful way for analysis, and communicate that knowledge to others in written form.

The general procedure, to be illustrated in this paper via a specific example, is as follows:

1. Generate data with an application computer program. Alternatively, it might be generated with a data acquisition system for a PC, or simply entered by hand..)
2. Import data into a spreadsheet.
3. Organize and label data using a spreadsheet.
4. Construct graphs of data using a spreadsheet.
5. Write the text to communicate the results of the project using a wordprocessor.
6. Import spreadsheet data into the wordprocessor for formal presentation.
7. Utilize special features of the wordprocessor to highlight the information and to shorten the overall preparation time.
8. Produce the hardcopy to communicate the results.

In a sense this an effort in synergism, meaning that we are combining elements of information processing to produce an overall solution that is more satisfactory that would gained by arriving at it using the tools independently. Diagrammatically, the process is shown in Figure 1.

DATA FROM ———> SPREADSHEET—> a.
PROGRAM

a.——> PRODUCE ——> PRODUCE ——>b.
GRAPH TEXT

b.——> IMPORT SPRDSHT. ——> PRINT
INTO WORDPROC.

Figure 1

Although, most wordprocessors and spreadsheet programs can be used, this paper will demonstrate the method using WordPerfect 5.1 and Lotus 1-2-3, Release 2.2.

Project Description

A very good example of a project can be found in a book by D.M. Etter [1:47]. In his example, a formula for predicting the growth of bacteria is given. The formula is shown below: (note that t=elapsed time in hours, Y=colony size.)

$$Y_{new} = Y_{old} \, (e^{1.386t})$$

In other words, you could start with a certain number of bacteria in a colony and predict the number which would exist at a later time. Observe that the formula in this report was created with the equation editor in WordPerfect.

Suppose a student project requires that a report be written on the growth of bacteria. The report is to include a table of the bacteria colony sizes for every hour beginning at t=0 and culminating with t=12. It is also desired that a graph of t versus Y be included. All of this is to be submitted as a formal paper.

The student would write (or obtain) a computer program in a source language to generate the data and dump it to a file. Remember that this data could just as easily come from a data acquisition system or manual entry. A BASIC program for this example is shown in Appendix A. The output file would contain 3 columns of numbers, 12 per column, and would represent the old colony size, the time, and the new colony size. This would be analogous to accomplishing *step (1)* of the general procedure, the generation of data.

Step (2) is accomplished by moving the contents of the data file into a spreadsheet, Lotus 1-2-3. From the Lotus menu the "FILE IMPORT" function is selected, the file pathname is specified, and the numerical data is imported. *Step (3)* involves arranging and organizing the data in the spreadsheet so that it conveys information which is meaningful. Since the colony size at each hour grows exponentially, it is necessary to add another column to the spreadsheet. This column is the log of the colony size, Y(new).

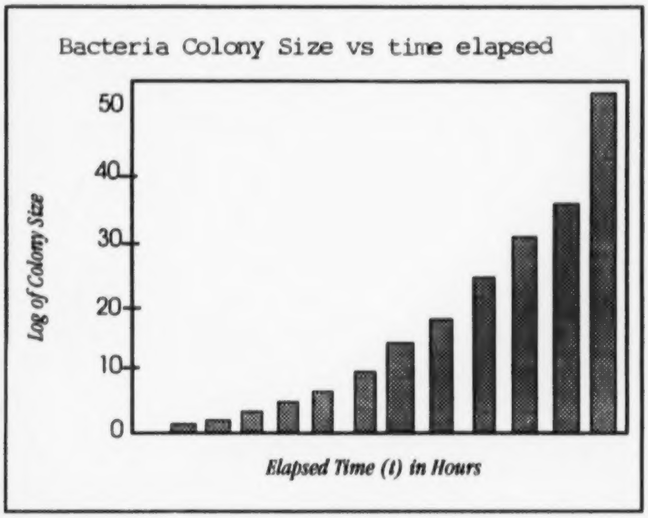

Figure 2.

When the spreadsheet is in final form, a graph of the information will be produced using the "GRAPH" function from the Lotus menu. The type of graph to be constructed will be a bar graph. That corresponds to *step (4)* in the introduction. A graph with sample data is shown in Figure 2. The graph must be saved and printed using the printgraph function of Lotus which is found in the Lotus access menu. (Note that you must have a printer capable of printing graphics to accomplish this step.)

Up to now the data that was produced from a computer program has been moved into a spreadsheet and manipulated to convey more information that would otherwise have been possible, without considerable time and difficulty. It is certainly feasible for a knowledgeable programmer to write a program to present the data in an informative manner, but it would not be realistic to expect the typical science student to be able to do this. *Step (5)* involves writing the text for the scientific report. This would be done with a wordprocessor. It is possible to do many things with your document using the advanced facilities which are available with WordPerfect 5.1. Two things that are essential in this particular example are: (1) the importing of the tabular information from the spreadsheet, and (2) creating the graph that was saved as a .pic file on disk with the Lotus spreadsheet. This corresponds to *Step 6* of our general process. When the table is imported, it will take the form of a neatly-outlined table with boxes, one for each of the cells in the spreadsheet.

To import the table you would use the "TEXT IN/OUT" function of WordPerfect. The program will present a menu with one of the options being "SPREADSHEET". Select that option, enter the name of the file, select the "IMPORT" option and you are done. The table will be positioned with its upper-left corner at the place where the text cursor is positioned. The table of the sample data is shown in Table 1.

Importing the graph is a straight-forward, trivial operation. To do this you would select the "GRAPHICS" feature from the menu, followed by "FIGURE" from the succeeding menu. Then you would use "CREATE" to set up the parameters prior to the import; the name of .pic file is the essential item at this point. Following that, the graph is moved into the document at the place where the cursor is located. There are many things that can be done with the figure after it is imported: it can be moved, resized, rotated, etc. These operations are beyond the scope of this paper, but could be accomplished to meaningfully enhance the information content.

Finally, the appearance of the scientific paper could be changed using a number of the useful features. A new word can be found to replace an overused one with the help of the online thesaurus, bold face printing can be done easily, as well as changing the font wherever a different style of printing would be more attractive. The possibilities available with the graphics and desktop publishing facilities of WordPerfect 5.1 are tremendous. One feature that all scientific writers would want to be familiar with is the equation editor which is invoked from a menu in the "GRAPHICS" function. Any mathematical symbol, of any size, can be created. Superscripting and subscripting as well as other functions are also available.

TIME (t)	COLONY SIZE	LOG
0	1.00	0.00
1	4.00e+00	0.60
2	6.39e+01	1.81
3	4.09e+03	3.61
4	1.04e+06	6.02
5	1.07e+09	9.03
6	4.36e+12	12.64
7	7.12e+16	16.85
8	4.65e+21	21.67
9	1.21e+27	27.08
10	1.27e+33	33.10
11	5.29e+39	39.72
12	8.83e+46	46.95

Table 1

Summary

The intent of this paper and the example have been to emphasize the possibilities that exist when one uses the common computer tools that are available on a campus. Most important is that they can be used in a coordinated, integrated fashion. Wordprocessing programs can be utilized with spreadsheet and database management programs. Taking the time to learn the features of application computer programs such as the ones we have used will open doors of opportunity for presenting information that heretofore might never have been considered.

Chemistry, biology, physics, math, agriculture, geology and computer science students will find nearly unlimited potential for expressing the results associated with their work. Lab reports, term papers, special projects, etc. become more than just humdrum typewritten pages when one creatively applies the tools at his disposal to them. Underpinning all of this is the concept of integration. We should be about the business of seeing things in an all-inclusive way; seeking ways of merging viable tools into our task activities. Toolboxes, today, are brimming over, but few craftsman have taken the time or effort to move beyond the obvious to the world of opportunity that awaits those who are willing to invest some time and effort in discovery.

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Appendix A: Sample Basic Program

```
10 'THIS IS A PROGRAM TO PREDICT THE GROWTH
20 'OF BACTERIA
30 '
40 'INITIAL POPULATION = 1
50 '
60 POPUL = 1
70 'INITIAL TIME = 1
80 TIME = 0
90 'NAME A DATA FILE (COMPLETE PATHNAME)
100 INPUT "DATA FILE NAME: "; DF$
110 'CALCULATE THE BACTERIAL GROWTH
120 '
130 'OPEN THE DATA FILE PRIOR TO CALCULATION
140 OPEN DF$ FOR OUTPUT AS #1
150 FOR I = 1 TO 12
160         LET POPNEW=POPUL*(2.718^(1.386*ELTIME))
170         PRINT
180         PRINT "INITIAL POPULATION ="; POPUL
190         PRINT "TIME ELAPSED="; ELTIME
200         PRINT "PREDICTED POPULATION="; POPNEW
210         POPUL = POPNEW
220         ELTIME = ELTIME + 1
230         'DUMP THE DATA TO THE FILE
240         PRINT #1, POPUL; ELTIME; POPNEW
250 NEXT I
260 END
```

Paper (T4-202B)

Approaches to Classroom-Based Computational Science

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Key words: computational science, modeling, simulation, physics, software-realized scaffolding

Abstract

Computational science includes the use of computer modeling and simulation to define and test theories about phenomena. It is an important new type of science with which students need to be familiar. This paper reviews approaches for providing computational science experiences in classrooms, describes research results, and discusses Emile, an environment which offers software-realized scaffolding to support student modeling activities.

Computer technology offers scientists today the opportunity of having a machine evaluate and present representations of their theories. The activity of creating computer-executable theories and evaluating the theories with powerful, interactive visualizations is called computational science [Denning, 1991]. Computational science is becoming as significant a branch of science as the empirical and theoretical traditions [Pagels, 1988]. The key components of computational science are:

- Modeling: Computers offer a metaphor for specificity in defining theories. Computer-based modeling (the process of defining a theory for simulation) requires that the scientist describe their theory in enough detail that the computer can execute it. Computer languages provide a notation for the specification of models.
- Simulation: Computers can execute a model (called simulating) and provide multiple representations of the process and final results (e.g., graphs, animations, numeric data). The combination of high-speed execution and various forms of visualization forms a synergy for highly interactive, exploratory analysis of theories.

Computational science is important for students of science for two reasons:

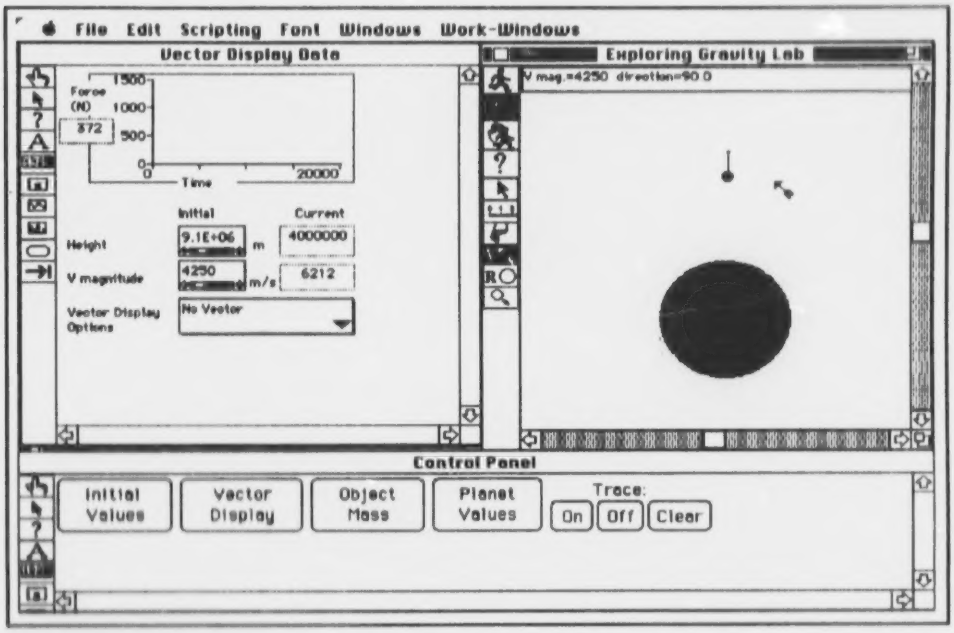
1. Computational science is a branch of science growing in importance. Understanding a significant new branch of science and the activities of real scientists is important for student literacy in science. We want students to understand science both to encourage their future participation in science as a career and to provide them with the means of understanding science as it appears in their lives.
2. What works for scientists may work just as well for students. Scientists use modeling and simulation activities to aid them in defining theories (modeling) and to enable them to gain insight into their theories (simulation). We might well expect students to gain similar benefits from computational science.

The challenge for educators is to develop techniques for implementing computational science in the classroom. This paper reviews some previous work on the use of simulations alone (without modeling), modeling alone (without simulations), and computer-based modeling and simulations. I also present some new work which uses scaffolding and an innovative classroom structure to support classroom-based computational science.

Simulations without Modeling in the Science Classroom

Richards and his colleagues [Richards, Barowy, & Levin, 1992] have taken the approach of emphasizing simulations instead of modeling in their science classrooms. Their approach has been motivated by a sense, from their experience, that traditional modeling is too complex for most students. Modeling requires certain skills that students may not have. For example, Hestenes has identified a problem that students have in seeing a scientific phenomenon in terms of components that can be modeled [Hestenes, 1987]. Richards et al. focus on having students explore simulations of expert-constructed models in an environment in which students use multiple representations and control various variables of the simulation in order to explore the model interactively (Figure 1). They feel that this approach can lead students to develop an understanding of models and to develop the skills necessary to undertake modeling activities on their own.

The problem that the simulations-alone approach faces is in getting the students to consider that the representations on the screen are more than a video game. Consider, for example, a popular video game such as Super Mario Brothers from Nintendo. When students are exploring this simulation of (at least nominally) physical phenomena, do they consider the underlying scientific model? For example, do they wonder about Mario's velocity and acceleration as he jumps up and falls back down? Do they consider the elasticity of collisions between Mario and the objects in his simulated world? For science learning to occur, there are two goals for a classroom emphasizing simulation:



Force (N) 372

	Initial		Current
Height	9.1E+06	m	4000000
V magnitude	4250	m/s	6212

Vector Display Options: No Vector

V mag.=4250 direction=90.0

Figure 1. A Physics Explorer simulation of gravity. Note the multiple representations (graphical, numeric, and vector) as well as the controls on the bottom of the screen.

1. The students must explore the simulation with a goal of understanding the underlying model. Without that, they can play the simulation as a video game without addressing any of the pertinent scientific concepts.

2. The students must relate the simulation's model to the real world. Without this attempt to transfer the knowledge, students might not address any of their existing preconceptions and change them to more theoretically correct conceptions [Champagne, Gunstone, & Klopfer, 1985].

As diSessa points out [diSessa, 1986], the educational issue is one of the setting for, and interpretation placed on, the simulation. Richards et al. avoided the student interpretation of the simulation as video game with focused in class discussions (1) which refer to the simulation as a representation of real world and (2) which direct attention to the details of the underlying model. Roschelle, for another example, solved the first problem but not the second in his research [Roschelle, 1991]. His students explored mechanics and kinematics in an abstract simulation called the Envisioning Machine. The Envisioning Machine used multiple representations of vectors and particle objects to describe the motion of objects in a Newtonian world, but without reference to Newtonian laws and without explicit labels such as "acceleration" or "velocity". To get students to reflect on the underlying model, he asked his students to force the particles to travel certain paths. Students using his simulation developed sophisticated underlying knowledge of physics (which he calls p-prims), but because this knowledge was not directly connected to the world of physics, the students did not relate the knowledge gained from his simulation to Newtonian physics. While they learned the Envisioning Machine, it was difficult to measure the physics knowledge they had gained.

Modeling in the Science Classroom

A second approach for classroom-based computational science is to ask students to create models, executable theories of scientific phenomena. The advantages of this approach are that it directly addresses the two concerns faced by the simulations-alone approach:

1. Because the students built the model, they describe the behavior of the simulation in terms of the underlying model. The literature on students' Logo programming demonstrates this phenomena, where students try to understand the behavior of their programs in terms of the procedures they entered [Harel, 1991; Papert, 1980].

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2. Because students build the model to describe the real world, the hypothesis is that they will relate the simulation results to the real world and thus transfer what they learn. Literature on Logo programming suggests that students do not often use skills learned in a simulated world in the real world [Pea & Kurland, 1986], but some literature on scientific modeling [Halloun & Hestenes, 1987; Sherin, diSessa, & Hammer, 1992] suggests that students do learn science principles from modeling activities.

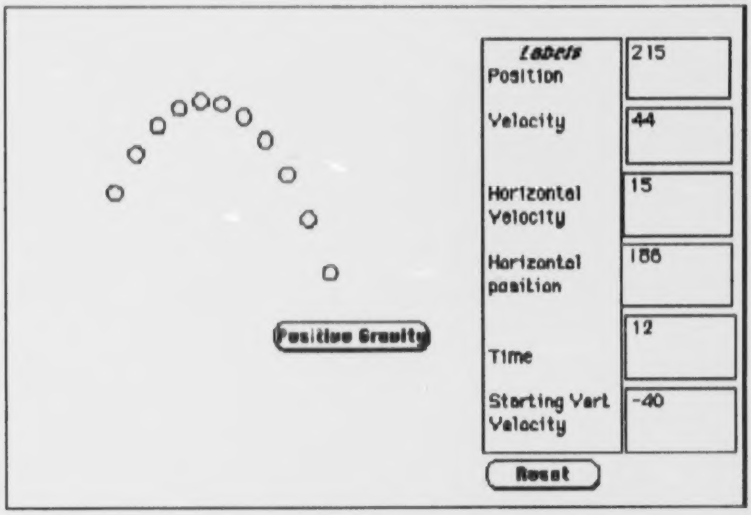
Hestenes and his colleagues and Sherin and the Boxer group at the University of California at Berkeley [Halloun & Hestenes, 1987; Sherin, et al., 1992] report that their students learn physics by developing models in class, as a joint activity, with the instructor and other students acting as the computer to evaluate and simulate the model. In these classrooms, students engage in modeling but without computer-based simulation. Hestenes had students use natural language and mathematics to define their models. Sherin et al. used the programming language Boxer as a notation for the model. Boxer provided a notation and a standard on which to base their model. However, the Boxer students did not actually implement their model, so they lost the potential advantages of the multiple forms of interactive representations available on the computer, which scientists use to gain insight into a theory.

Computer-based modeling (which would then lead naturally into computer-based simulations) has been difficult to implement in classrooms. For example, Tinker and his colleagues [Tinker, 1990] conducted a four week workshop for high school students to teach them modeling skills in two computer-based modeling environments (Stella [Mandinach, 1989] and Microsoft Excel). Tinker reports that traditional classrooms are not structured to implement computational science activities: It's difficult for students (Tinker's study used three weeks of preparatory instruction before starting modeling), it's difficult for teachers who have never had such experiences themselves, and traditional curricula are not conducive to modeling activities.

Emile: An Approach to Computer-Based Modeling

The challenge, then, is (1) to provide the advantages of modeling over a simulation-alone approach, (2) while avoiding the problems identified by Tinker, and (3) while gaining the learning-through-modeling reported by Hestenes and Sherin and their colleagues. My approach to this challenge is Emile, a programming environment running on the Apple Macintosh in which students construct kinematics simulations and multimedia demonstrations [Guzdial, 1993]. I evaluated Emile in a three week (Monday through Friday, three hours a day) workshop in which five high school students created three simulations and a multimedia demonstration of velocity, acceleration, and projectile motion. None of the high school students had any previous high school physics, none had any previous Macintosh experience, and three had never programmed before.

Figure 2 is a screenshot of a sample project developed by a student (without previous programming experience) using Emile. This project is a simulation of two-dimensional projectile motion. A user clicks down the mouse button with the arrow on the Positive Gravity object, drags the object somewhere on the screen, and releases the mouse button. The object then launches with the specified horizontal and initial vertical velocity, eventually falling back down in an accelerated motion as if under the influence of gravity. The student built this program in three days.

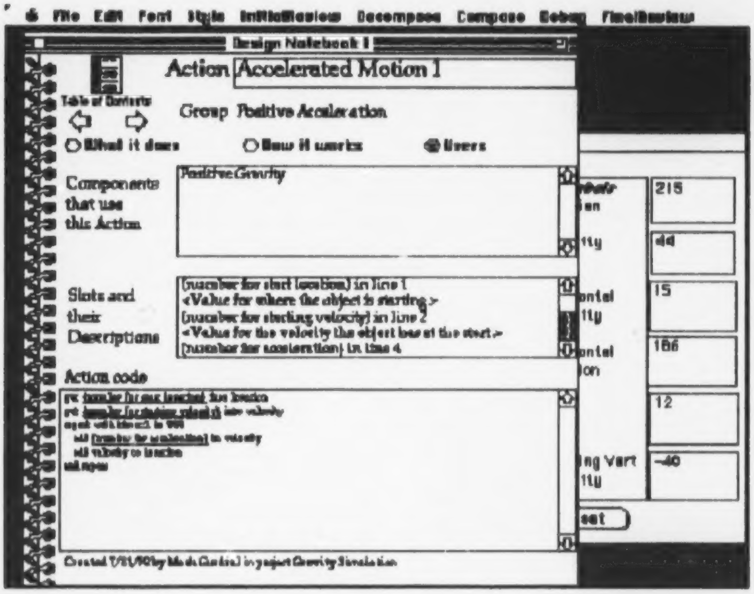


Labels	
Position	215
Velocity	44
Horizontal Velocity	15
Horizontal position	186
Time	12
Starting Vert Velocity	-40

Figure 2. A student's 2-D projectile motion simulation, created in Emile.

There were two key factors which were used in the Emile approach. First, Emile offered extensive scaffolding for modeling activities. Scaffolding is support (most often provided by a teacher) which enables students to succeed at an activity which they might not succeed at without the support [Collins, Brown, & Newman, 1989; Farnham-Diggory, 1990; Palincsar, 1986; Rogoff, 1990]1. Emile's scaffolding was realized in software, and it included:

- Mixed-media programming framework: Students programming in Emile did not type traditional textual programs. Instead, they assembled programs out of chunks of text program called actions which performed a specific task and could be manipulated as a unit, and graphical objects such as the Positive Gravity button. Students programmed in Emile by assembling actions into buttons, rearranging the actions in the order in which they should execute for the model, and filling blanks in the text programs called slots. These slots had domain-specific roles for which they were named, such as "Number for starting velocity" and "Number for acceleration." (See Figure 4.) Thus, students using Emile did not have to learn text program syntax, they were able to use graphical as well as textual programming elements, and these elements were tied tightly to the kinematics domain.


File
Edit
Font
Style
InitialReview
Decompose
Compose
Debug
FinalReview
Design Notebook 1
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What it does
How it works
Users
Action code
215
44
15
186
12
-40

Action Accelerated Motion 1

Group Positive Acceleration

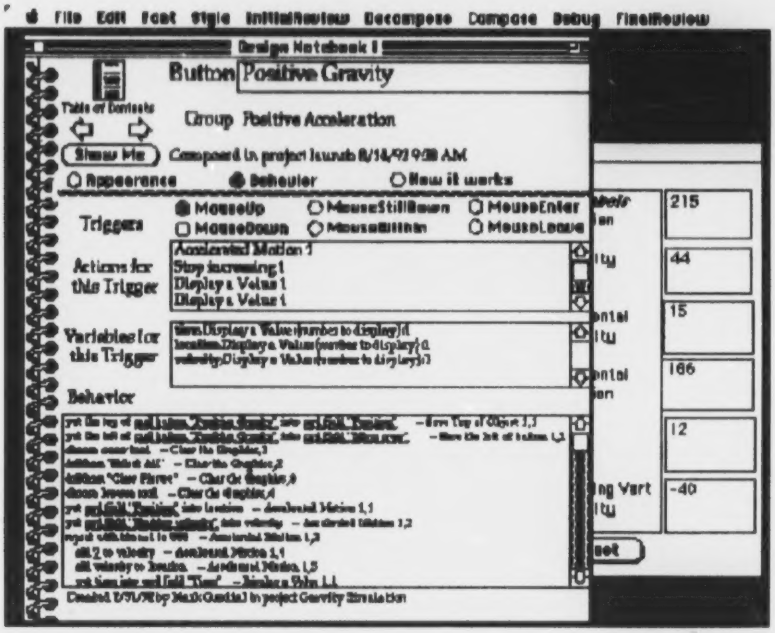
Components that use this Action: Positive Gravity

Slots and their Descriptions:
[number for start location] in line 1
<Value for where the object is starting.>
[number for starting velocity] in line 2
<Value for the velocity the object has at the start.>
[number for acceleration] in line 4

Figure 3. The page for the action Accelerated Motion., provided for the students in the basic Emile library. This is a text program component that a student will use, reorder, and modify in a button's behavior. Notice that the slots (underlined) are named in terms of the kinematics domain, such as "Number for acceleration." The partially obscured window is the Project Window where the student creates the simulation (seen in Figure 2).

- Prompts for articulation and reflection: Emile prompted students to articulate and reflect often on the program being created, on the program as a model, and on their process. These prompts included project descriptions, plans, predictions, and journal entries.

- Design Notebook: All of a student's work on a project, from articulation entries to program components, was stored in a single Design Notebook. The Notebook is a collection of components and tools arranged one to a page with several navigation facilities provided for movement between pages.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Button Positive Gravity

Group Positive Acceleration

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○ Appearance ● Behavior ○ How it works

Triggers ● MouseUp ○ MouseStillDown ○ MouseEnter ○ MouseDown ○ MouseWithin ○ MouseLeave

Actions for this Trigger
Accelerated Motion 1
Stop increasing 1
Display a Value 1
Display a Value 1

Variables for this Trigger
time,Display a Value(number to display)1
location,Display a Value(number to display)1
velocity,Display a Value(number to display)1

Behavior

Created by Mark Guzdial in project Gravity Simulation

Figure 4. The page for the button Positive Gravity, provided for the students in the basic Emile library. Positive Gravity was used as a template for most of the students' simulations. For example, the student who created Figure 2 used Positive Gravity as a starting place for his 2-D projectile simulation. Actions are identified in the behavior by a suffix on each line (compare the lines annotated with "Accelerated Motion" with Figure 3).

- Library of Components: Emile provided over one hundred basic programming components for students to use in creating their programs. These components ranged from actions that embodied basic kinematics concepts, such as "Accelerated Motion" (Figure 3), and a button that simulated one-dimensional projectile motion (Figure 4), to buttons that displayed digitized video for multimedia demonstrations. Students made extensive use of the library in the creation of their programs.

An important aspect of Emile's scaffolding is that most of it could be faded (that is, reduced or removed) under student control. For example, if a student wanted to type text programs directly, instead of using the mixed media programming framework supplied by Emile, she could easily turn off that scaffolding and directly type text programs into buttons. Three students were typing text programs by the final project in the workshop, while two other students continued to use actions and slots throughout. Thus, in the final program, all five students were using Emile to create projects of similar complexity, but they were using tools and programming at a level chosen by them.

The second key factor used with Emile was the design of the workshop environment and curriculum. The workshop was set up to encourage motivation and collaborative discussion.

- Authentic task: Students were told that they were creating their programs for other physics students. While students never met their audience, they made their design decisions with an audience in mind, e.g., choosing some features over others because of the modeler's estimation of other students' interest. Thus, the students' task had authenticity: it had a real audience. An authentic task helps in promoting student motivation2 which is an important factor in student success at such a complex task as modeling [Blumenfeld, 1992; Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991].
- Collaborative atmosphere. While students worked on their own projects, the students collaborated in the sense of "collaboration in the air" [Kafai & Harel, 1991]. Students would often wander the room, reviewing each others work both for techniques that they might use and to critique each others' project. Students did not hesitate to note "But that's not how the real world works." The ensuing discussion was

significant for both the developer and the reviewer in encouraging reflection on the model and on its role as a theory of physical phenomena.

Students were evaluated on their science learning with a clinical interview (using a similar technique as [Finley, 1986]) where students were asked to verbally solve problems in physics both at the beginning and end of the workshop. Further, the students were probed for a detailed description of their physics understanding. I found that all five students improved in their conceptualizations of velocity, acceleration, and projectile motion.

For example, one problem involved estimating the velocity and time to impact of a rock dropped from a three story building. On a pre-test, student B simply gave up on the problem, saying "And the velocity is, let's see, gravity...ummm...I can't remember that." On the post-test, student B was able to elaborate a far more sophisticated understanding. In fact, as seen in the below quote, he seems to mentally simulate the second-by-second falling of the rock:

B: It would be about one second

R: Okay, where did you get that from?

B: If the acceleration is 30 feet per second per second, then per second it will be going 30 feet per second, then...it will just take a little longer for it to get to the ground.

R: Why?

B: Because you have to divide to get the average velocity, which is how fast it's going, and how you can measure how far it's gone, you have to...let's see...it will be going, it will be going 15 meters per second. Maybe two seconds, I guess.

R: Why?

B: Because...1.5 seconds. Because, by the time it's accelerated the second second, it will be going about 45 feet per second, so it'll have to be between the first and second second that it hits the ground.

An approach such as the one used in Emile may not be any easier for teacher's than the ones described by Tinker. So the issue of supporting teachers who are themselves unfamiliar with computational science is still an open issue. However, the Emile approach does hold promise for reducing the complexity of modeling for students.

Summary

The two key components of computational science are modeling and simulation. This paper has reviewed the literature of approaches to classroom-based computational science and presented a new study which offers a new approach to supporting student modeling.

- Simulations can be used apart from modeling, by using models created by an expert. The advantage to this approach is that it avoids the complex activity of modeling for students. The danger of this approach is that students may not reflect on the underlying model and its applicability as a theory of the real world. A successful approach described here is to use classroom discussion to raise critical questions and to relate the simulation to science.
- Using modeling without computer-based simulation encourages reflection on the model and its role as a scientific theory, but loses the potential advantages of individual, interactive exploration of the model through a simulation, which scientists use to gain insight into theories.
- The approach used with Emile is to allow students to create their own models, but in a programming environment that offers extensive scaffolding. Further, Emile was used in a workshop that featured authentic tasks and encouraged collaboration. While there are still open questions for use of this approach (such as how to prepare teachers for classroom-based computational science), it holds promise for diminishing the complexity of modeling for students.

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[1] A more elaborated discussion of scaffolding and software-realized scaffolding can be found in [Guzdial, 1993].

[2] The study described here is not a test of the value of the authentic task, especially since the students were already so motivated (e.g., volunteering to attend a summer workshop).

Project (T4-203B)

101 Great Telecommunications-Based Collaborative Science Investigations That You Can Join

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Key words: telecommunications, collaborations, investigations, science

Abstract

With increasing access to world-wide telecommunications, students, teachers, and scientists are embarking on an amazing variety of collaborative investigations. These national and international projects, all of which include the sharing of data by telecommunications, enable students to be directly involved in hands-on science, exploration of topics of personal interest, communication with students world-wide, and participation in real scientific investigations. This is a powerful way to teach science, develop thinking skills, and promote group communication and problem-solving skills.

As the developers of NGS Kids Network, Global Lab, Alice Network Software and other telecommunications initiatives, TERC is in frequent contact with "telecommunications-enhanced collaborative investigations" that are eager to have new participants. In this workshop, we will share descriptions and contact information about these projects, both to help them in their recruitment of potential participants, and to present a range of opportunities for educators who are interested in such directions.

This workshop will present a list of 101 (more or less) such projects, each with a brief overview and contact details on how you can join. The list will be provided on paper and on disk, as well as being available on the Internet. A core group of the projects, with which TERC has had direct involvement, will be described in detail to illustrate key concepts.

Project (T4-204A)

Teachers and Technology: Making Connections

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Key words: staff development, curriculum, high school, distance learning, media delivery

Abstract

Cotter High School's underlying focus is to continually improve our student's education and provide an environment that will enhance that process. Being attentive to student needs, emphasizing technology and focusing on teachers is our approach to constantly work toward that goal.

We believe to affect the curriculum and profoundly affect our student's educational outcomes, the teachers needs must first be considered.

In our staff development plan we strive to draw on our teachers' talents, creativity and strengths. In this way we hope to continually affect and improve the curriculum for our students. In this approach we constantly have to struggle to be a whole system...not just individuals in departments with everyone seemingly competing to be more important than the other.

Since the introduction 1 1/2 years ago of technologies such as portable computers for each teacher, E-mail, voice mail, a phone on each teacher's desk, a campus wide media delivery system and satellite programs, the Cotter atmosphere has been one of great excitement and also apprehension. But we do not only have a lot of new hardware, we also have a

commitment to continually adapt to change because student needs change, teachers ideas always need to be considered and of course the ever-changing technologies.

Our plan involves an aggressive approach which is continually committed to training all teachers in electronic mail, word processing, data bases, spreadsheets, desktop publishing, presentation software, electronic grading, multimedia such as scanners, video, still video and audio capture as well as using CD ROM and laser disc technology as resources.

In year two our focus now is on finding out what will work for individual teachers and students in specific areas of study. We continue to explore technology resources in all curricular areas, we brainstorm with other educators, we explore software, media and resources in all disciplines and we continue to provide guidance and collaborative lesson planning opportunities.

We truly believe this staff development commitment is the key to our successful project. The teachers are comfortable in using the technology for communication, distance learning, media delivery, locating resources, presentation, grading and organization. Because of this, they are able to integrate technology into their lessons and most importantly, let their students utilize the tools that provide a more active and meaningful learning experience.

Project (T4-204B)

Affect and Effect of HCI Paradigms on Learning and Using Logo

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Key words: Logo, computers in education, HCI, human-computer-interface, computer science instruction

Abstract

Social and behavioral learning theories agree that learning occurs by engagement in our environments. Teachers tacitly accept and exhibit this in the way we arrange classrooms; rows of desks facing a chalkboard and educational displays are aimed at creating an environment where students can learn.

In computer technology, a graphic user interface (GUI) provides these and two other things that can facilitate learning, immediate and consistent feedback to user input (Apple, 1987). Ideally, fast and consistent response promotes an understanding of the environment and a feeling of control that builds confidence (Apple, 1987). However, research shows that even when these elements are available in a human-computer-interface (HCI) a user may still not learn what action caused a discrete feedback to occur (Svendsen, 1991).

Svendsen found persons using GUI interfaces performed better than those using a command-line interface typical of DOS computers. But error rates and understanding of the task for GUI users was inferior to users of the command-line. The cause may be partially due to aspects of language as a known medium for interaction.

Our contention is that the HCI is more appropriately modeled as dialectically learned language than a system of metaphors and analogies common to modern GUI's. Interfaces tested offer three levels of input and feedback equating to levels of language development of Vygotsky (1978; 1986) and Gardner (1983).

By focusing the pragmatics of input and feedback it may be possible to combine advantages of GUI's (Hannafin & Peck, 1988; Microsoft, 1992; Rauterberg, 1992; Shneiderman, 1992) with the effect of Svendsen's (1991) findings.

We present learners with GUI control buttons labelled with (1) verbose descriptions of effect, (2) Logo-code description of effect or (3) iconic representation of effect on the Logo turtle.

We also investigate the affect and effect of various feedback in response to command input by providing, (1) explicit natural-language feedback, (2) Abbreviated "code" language feedback, or (3) no feedback to commands.

Using language as a computer command medium is not new, however, technology has not produced a machine fully capable of natural language. Modern natural-language-processing (NLP) require that the user must know the syntax of a command before using it (Apple, 1987; Microsoft, 1991; Suh & Jenkins, 1992). Until commands are learned, computer users must occasionally interrupt their activity to lookup commands.

From an HIP (human-information-processing) standpoint one cannot argue against pedagogical potentials of GUI (Shneiderman, 1992; Svendsen, 1991). A faster learning curve (Rauterberg, 1992; Svendsen, 1991) supports more rapid mastery of commands.

Such additions to an HCI may satisfy HIP theories that well-learned skills lessen "cognitive load" and permit focus on higher level tasks (Perkins, 1985; Perkins & Salomon, 1989).

Below are descriptions of the treatments used:

1. CC (Code-Code): buttons labeled with Logo code used to command turtle. Feedback echos the Logo command issued.
2. VN (Verbose-No feedback): buttons labeled with verbose description of what the turtle will do when command is used—No feedback.
3. IV (Icon-Verbose): buttons with graphic icons representing turtle action. Feedback echos a verbose description of command.

Revolutionary Classroom (T4-207A)

New Forms of Communication Are the Heart of the Revolution

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Key words: revolution, technology, telecommunications, multicultural

Abstract

June 1989....Boston...my first NECC conference. There were planted the seeds of change that revolutionized not only my classroom but ultimately brought change to the schools in our county, the attitudes and thinking of our school administration, and to the relationship between our schools and our community. At that NECC conference, I witnessed the power of telecommunications, experienced the excitement of multimedia and met teachers who were on the front lines of education, not just technology. Teachers whose classrooms promoted real learning and real involvement.

I bought technology, brought it into the classroom and began to join forces with those fellow educators who believed that teachers are the heart of education reform. I was a changed person, excitedly learning from these new experiences along with a classroom full of eager apprentice learners. But, just as important, were the developing relationships with other teachers. These relationships I believe are the most effective route to school change.

Revolutions happen because of communication. Revolutions are the act of a large number of isolated individuals who have grasped the power of collective action. Alone, rebels find it hard to create revolutionary change. I have joined in, signed up, and I am changing the ways teachers teach and students learn. New forms of communication are the heart of the revolution, breaking down the isolation and the driving forces of change.

Revolutionary Classroom (T4-207B)

Wonder of the Woods—Technology and Integrated Thematic Instruction

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Key words: Thematic instruction, science, language arts, elementary, Special Education

Abstract

Bugs! Worms! Lizards! These are the kinds of things that intrigued elementary students as they studied "The Wonder of the Woods", a year long theme. All content, academic skills, and technology skills were woven into what is called Integrated Thematic Instruction. These students learned from their immediate environment and from concrete, first hand experiences with the animal and plant life in the nearby woods. They then incorporated these experiences into language arts, reading, science and art through the use of technology. Their reports and presentations came alive with video footage taken during their treks to the woods. Editied video clips were imported as QuickTime movies into their reports. In depth studies were made of birds, ants, worms, lizards, frogs, and bees with the Visual Almanac and Grolier's Electronic Encyclopedia as well as traditional literature. Graphics and sound enhanced their word processed reports. Slideshows, complete with sound and special effects were developed with their own computer drawings and electronic flip book poetry was created with HyperCard. One would never believe these were learning disabled students.

Beyond Traditional Boundaries: Coping With Multiple Intelligences in Today's Classrooms

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Key words: multiple intelligences, computer-centered, task-based, language development, integration, learning styles

Abstract

Many well-intentioned teachers are working hard to teach children who fail to learn. Teachers must strive to enhance their power as educational connoisseurs and critics, professionals who understand how to use technological learning materials that carry learning beyond traditional classroom boundaries in order to promote growth across multiple intelligences.

Discover how this challenge was met in a secondary classroom in Ottawa, Canada. Theory-rich computer-centered pedagogy woven through a "lesson ideas matrix" based on Gardner's 1991 book *The Unschooled Mind: How Children Think and How Schools Should Teach* forms the basis of this interactive session. Engage in a powerful learning task that cannot be done without a computer. Explore the significance of language links in a learner-directed environment. Come to understand more about the teacher's role as a facilitator of learning. Reflect upon how this integrative approach can be adapted for learners from Primary through Adult levels of education Discover how this dynamic approach promotes professional self-awareness and growth.

This session springs from the presenter's doctoral thesis in education at O.I.S.E., University of Toronto. Funded for development by the Ontario Ministry of Education, the software is part of the *Ontario Assessment Instrument Pool for Basic*

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English. For more information about the software, contact Technolinks™ Inc., 273 Stewart St., Ottawa, Canada K1N 6K3 Telephone (613) 789-6716.

Distance Learning (T4-306A)

Distance Learning: A Smorgasbord of Options—Phone Line to DS3

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Key words: distance learning, delivery media, computer conferencing, audio-graphics, high school, graduate programs, New York Institute of Technology

Abstract

The New York Institute of Technology has an ongoing Distance Learning project that is developing the delivery of instruction using the full range of distance delivery media to varied audiences. The project, initially funded by Northern Telecom Inc., and subsequently by the New York Telephone Company has looked at a variety of delivery systems: computer conferencing, audio-graphics, audio-conferencing, full motion two-way audio/video, one-way video and two-way audio. Each of the delivery modalities was piloted to determine the effectiveness of the delivery, hardware and personnel requirements, technical problems, and the cost of delivery. The target audiences covered high school to graduate students.

Discussion

The computer conferencing system is being used to deliver undergraduate programs and components of off site graduate programs. An extensive study of the efficacy of delivery was used by the Institute for its submission to the State Education Department of New York for its off-site graduate program. The undergraduate program serves local, national, and international students with a range of undergraduate programs.

The Audio/graphics, audio conferencing, and two way audio/video systems have been used for the past three years to deliver instruction between two campuses of the New York Institute of Technology that are about forty miles apart in Islip and Old Westbury on Long Island. Satellite delivery has been used in conjunction with the Inter County Teacher Resource and Computer Training centers to deliver In-service education.

The presentation will detail the systems (*hardware, software, instructional, methodology*) which must be put in place and the outcomes which have been possible on the varied delivery systems. Problem areas and troubleshooting issues will also be discussed.

Project (T4-308A)

Transforming the K-12 School: Success at the Summit!

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Key words: K-12, school reform, technology integration

Abstract

Through the teaching of lifelong learning skills that include those of mastering computer technologies, teachers are transforming the academic program at The Summit Country Day School. Wonderful success has resulted from the integration of computer technologies on all grade levels and curriculum areas.

Transforming the K-12 school

We are witnessing in our society an era of unparalleled general support for educational reform. One impetus to reform arises from our recognition of great technological transformation that is occurring within our society. We also know that meaningful educational reform must be based on the needs of learners rather than on administrative convenience or academic tradition. Assessing needs and responding appropriately is the special challenge in this period of transition.

Though we cannot see the future, the vision of the learning process that may characterize 21st century learners and the tools they'll use is becoming clearer year by year. It's already quite clear, for instance, that the high school graduates of those times will need to be very comfortable in a technological environment. They'll have to be, as technology and computers will certainly play a pervasive role in virtually every aspect of schooling and in every workplace he or she will enter.

At The Summit Country Day School, we feel that we are providing a slice of that future to our students today! We are transforming our school and our academic program as we provide our students with lifelong learning skills that include those of mastering computer technologies.

At the heart of our philosophy is the belief that each student is to be actively involved in learning activities that are authentic and multidisciplinary in nature. Thematic unit activities employing a variety of computer technologies are completed in small group settings where collaboration with learning team members is valued. The role of the teacher is becoming that of coach, motivator, guide, and resource person. Teachers are called upon to model the type of learning behaviors they seek to develop in their students, witnessing to the fact that learning *is* a lifelong venture.

We use computer technologies on all levels of our K-12 school. Initially, we use computer technology to enhance a "process writing" approach on grade levels throughout our school. More than developing the ability to put just text on paper, we teach students to add creativity to their projects in a variety of ways. They then develop their skills as ***publishers*** of their own work—**desktop publishers**! Numerous computer activities evolve from this "productivity-oriented" use of computer technologies. We have an ethernet fiber-optic computer network throughout our campus to extend our resources to all students and school offices. On this network are four computer labs and computers distributed in classrooms throughout our school.

We've had wonderful success throughout our school these last few years in the use of computer technology. Our experiences have transformed our K-12 school of 950 students. Students in each grade of our school primarily use Macintosh computers along with scanners, video cameras, and laser printers to add quality and creativity to their reports, themes, term papers, newspapers, and projects (in art, science, mathematics, language arts, social studies). Examples from early elementary, middle school, and high school projects will be presented.

Impacting your school (1-8, 9-12, or K-12) in positive and **dramatic** fashion by utilizing computer technologies and computer networks is quite possible. ***We feel strongly that what we are doing at The Summit can be replicated in other schools across the country.*** In this presentation we'll summarize our techniques and approach.

Project (T4-308B)

A Middle School Restructuring: Four Teachers' Experiences With Technology

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Key words: information technology, New American School, restructuring, interdisciplinary, science probes, computer

Abstract

This is a dissertation study in progress that describes the experiences of four middle school teachers who were immersed in a technology rich environment when their school was designated as a year one, New American School in the

summer of 1992. A qualitative design has been used to collect data over a two year period from multiple sources representing how the technology is being used to facilitate school change and how it is being assimilated as an innovation. Using document analysis, participant observation and recursive interviews, these teachers and their school were examined in the context of their philosophy of education and restructuring history to determine how the newly acquired technology effected the interactions, feelings, roles and relationships of the students, staff, administration and community.

Body

Preliminary analysis of the data reveals the following emerging themes: 1) Systematic change is complex and slow and focuses on many interrelated directions at once. Using technology represents only one small piece of what it means to be a restructuring school. 2) Teachers need to feel they are in a safe environment in order to take a risk and try new methods and technologies. 3) Change produces tensions and conflicts that are intensified when progress towards new educational goals are measured by old educational assessments. 4) Although the teachers agree that using information technology with their students is important, an inordinate amount of time and energy is needed to become computer literate, to explore the new opportunities and new technology enhancements, and to find ways to articulate how information technology can shape and enrich the curriculum. 5) Learning about new ideas and new tools evolves through different levels of personal comfort which in turn determines at what level and degree the teacher integrates technology into their curriculum and practices. 6) Using computers with students can promote the implementation of many of the goals and visions of educational reform or reinforce and improve the efficiency of traditional models of education.

A specific example is included in our presentation that demonstrates how these four middle school teachers are using their new technology to help expand the options of what is taught, how it is taught, and how it is managed and assessed. This team designed and implemented an interdisciplinary water project in which all sixty one of the middle school children participated. This school is located on an island in Lake Champlain and to many residents the lake represents a critical component of their physical, biological and economic environments, depending on it for their drinking water as well as source of income. The students in Vermont used electronic probes, chemical tests and observational skills to determine the health of their water. Five sites on Lake Champlain were analyzed for chemical and biological makeup. Computer applications such as spreadsheets, drawing programs and word processors were used to research, manage and analyze the information, digitized photography, video and hypermedia were used to present and share the information learned. The students electronically linked with another middle school in Murray Kentucky, to compare the quality of their water sources and extend their understanding of other environments and cultures. In the process of using the tools of technology to investigate their environment, the teachers in the middle school adapted their curriculum to reflect the skills that the students would need to conduct this study. Discrepancies in data between chemical and computer probe analysis led children to question results and write to a number of environmental resources for an explanation. Further use of these computer probes has led students to work in cooperative groups to conduct experiments of their own focus and design.

Society Session (T4-310A)

Networks and Distributed Computing (ACM SIGCSE)

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Key words: networks, distributed computing, programming environments

Abstract

The tremendous advantages associated with connection of computers into networks brings increasing demands for applications to take advantage of this environment. Programs written to work in a distributed computing environment pose a class of problems different from those encountered in programming a single system. This session explores the requirements a distributed computing environment makes on program development. Some of the requirements are locating data in distributed files, addressing replication of data and the associated question of consistency, remote execution of part of a process, dealing with partial failure in the computing environment, and resolution of conflict resulting from concurrent access. The session will address these issues and others and will assess their impact on the future of programming instruction.

Project (T4-313A)

Fact in Fiction—A HyperCard Research Project

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Key words: HyperCard, research skills, writing process, learning process

Abstract

Students can enhance an author's work of fiction by extending the factual background by emulating how writers employ primary field experience or secondary research to enrich stories. The factual foundation of fine writing may not be readily apparent when reality is blended with imagination. When young authors analyze successful work and discern and replicate the many ways by which a storyline becomes life-like, they are acquiring powerful writing tools. They are also developing valuable research strategies and learning techniques applicable to future endeavors.

Computerized formats lend themselves to this learning process by making it easy to show the separation of an author's work from a student's expansion. The nature of the research, the specific content, the means of incorporation, can be showcased and isolated, giving evidence to student and teacher alike of the contribution that such an effort has made. The simplest word processor can use (parens) or underlining or **boldface** or italics to differentiate. A non-linear program, such as *HyperCard*, has limitless ways by which to augment a text. As students explore these avenues, they are gaining the capacity to enrich their own compositions in linear or non-linear formats that invite a variety of implementation of fact and idea.

Introductory student activities include analysis of favorite authors' works. Students explore how authors use information to bring characters and places and times to life. They practice inserting additional information in a relevant manner. A few of the paths they may follow will be to sustain a mystery setting through geographical research; to further describe an environment requiring substantial survival skills; to incorporate colloquialisms within dialogue; to detail an animal's life cycle or potential enemies; to animate how an invention works; to further verify a historical outcome or to question any information within a composition; to provide accurate sound effects or visuals, such as the messages of a ship's flags or a train's whistle; to define, cross-reference, chart and label; to refer to timelines; to provide a contemporary analogy; to include or explain cultural traditions. *HyperCard* makes it possible for numerous variations of any one of the above techniques by individuals to be available through its branching capabilities. Browsing through several such insertions can be used to develop criteria or standards, or to provide a panoply of creative models.

A subsequent approach is to utilize the structure of a short story or a primary-level book or the final chapter of a novel to build a unique *HyperCard* stack that requires extensive research. This project lends itself to pair and group work and is especially helpful in peer teaching of computer, writing, research, and other skills. The interactive potential of such a stack can be emphasized, asking for predictions that utilize researched information, incorporating teasers or clues, providing 'choose-your-own-adventure' choices of different cultures, different animals, or science fiction on different planets.

The bridge may be crossed to independent Hypersearch projects and those focused on science, social studies, or other curricular needs as students absorb the necessary research, writing, and technical strategies. Such stacks can include unique educational advantages. When information in Hyperstack compositions has verification embedded via pop-ups or other technical means, these stacks become valuable as resource material for other students as well as for their story appeal. Also, such hyperstacks can conclude with inviting student-designed assessment screens prepared variously for peers, teachers, librarian responders.

Project (T4-313B)

An Interactive Tutorial to Teach Programming Using HyperCard

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Key words: HyperCard, programming, interactive, tutorial

Abstract

In the Introduction to Computer Science course that I teach at the College of Saint Rose, the main goal is to have students become computer literate. We define computer literacy as the ability to use a computer to develop your own ideas.

The Project

In the first part of the course, we have our students build projects using *HyperCard*. *HyperCard* is an authoring system that lets non-programmers create computer applications. *HyperCard* works only on the Macintosh, but there are similar authoring systems, such as ToolBook, that are available for the IBM platform. The computer applications that students create are modeled on a stack of cards. Each card can contain graphics, text, and buttons. Buttons can be used to link cards or to activate programs.

For example, a *HyperCard* stack on the Zodiac might include one card with buttons for each astrological sign. When a user clicks one of these buttons, a card would appear on the screen that contains a horoscope for that sign. The user can then click another button to get back to the original card.

In the second part of the course, students how to use HyperTalk, the programming language inside *HyperCard*. HyperTalk contains programming commands for arithmetic calculations, if then else statements, while and for loops, user defined functions, graphics, and sound. Usually students are highly motivated to learn HyperTalk because they like to enhance their projects by adding sound and animation to their stacks. Depending on the application they create, students often see the need for arithmetic calculations and if then statements. So students understand why programming is useful before they start programming.

To help students learn programming, I have created *HyperCard* stacks that are a self-paced tutorial on HyperTalk. My tutorial includes chapters on graphics programming, arithmetic calculations, if then statements, for and while loops, user-defined functions, and some HyperTalk specific commands (such as message passing.) In each chapter, students learn new concepts. Students test their knowledge by modifying sample programs in the tutorial and by writing new programs. Students get immediate feedback on their learning.

Students have enjoyed using the tutorial as an adjunct to more traditional lectures. I have found that students like to learn programming at their own pace, and they like writing and modifying programs in computer labs. I have also found that I can intervene quickly when students are having difficulty applying a certain new concept.

In my project demonstration, I plan to show how *HyperCard* works, how applications can be built without programming, the mechanics of how to program in HyperTalk, and how students use my tutorial. Conference participants can both try out my tutorial and copy it for their own use if they wish.

Conference Sessions

Wednesday, June 15, 1994

Session summaries, research papers,

& presenter contact information

Paper (W1-201A)

Laboratories for a Liberal Education Computer Science Course

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Key words: computer science laboratories, liberal education, computer science education

Abstract

This paper reviews the laboratory component of a new computer science service course offered at Miami University. Rather than focusing on computer tool skill building, laboratories are designed to develop liberal education skills such as critical thinking and engaging with other learners. Students do not develop proficiency in any one package, but instead are exposed to the potentials and limitations of many.

Introduction

Academic departments, including Computer Science and Information Systems departments, have long recognized the need to provide service courses to students outside their department. In the case of Computer Science and Information Systems, these courses can generally be classified as skill building or computer literacy.

Both of these kinds of courses usually have a significant lab component in either an open or closed lab format. Laboratories in such courses typically focus on gaining proficiency in a particular package or a set of packages through hands-n activities. Scores of texts (e.g. Pitter, 1992; Duffy, 1991) have been written to support such classes. During laboratories, students either follow the books hands-on tutorial or complete in-class activities designed to help them master the package. An alternate approach to service courses in the computer science area is a lecture style presentation of computer science concepts. This type of course frequently deteriorates into a presentation of terms and their definitions occasionally appended with a "show and tell" demonstration of computer hardware.

The major thesis of this paper is that computer science from a liberal education view can be approached in a very effective way by using laboratories, but with a different purpose than skill-building or term memorization. This paper reviews the laboratory component of such a computer science service course offered at Miami University. Rather than focusing on skill building, labs are designed to develop liberal education skills such as critical thinking and engaging with other learners. Student lab groups experiment with the computer, make hypotheses, and then conduct further experiments of a more specific variety. Students do not develop proficiency in any one package, but instead are exposed to the potentials and limitations of many. All labs are developed with the objective of deepening students' liberal education.

Course Overview

Miami University has long been known for the quality of its liberal arts undergraduate education (Moll, 1985). In keeping with this tradition, Miami began an extensive review and revision of its undergraduate liberal education requirements in the mid-eighties. This effort resulted in the Miami Plan for Liberal Education (Miami Plan, 1989). A set of liberal education foundation courses is one of the major components of the Miami plan. A student must choose foundation courses from each of these five areas: English composition (0 to 6 hours), fine arts and humanities (9 hours), natural science (9 hours) and mathematics formal reasoning and technology (3 hours).

Systems Analysis 151 (Computers, Computer Science, and Society) is a Liberal Education foundation course in the technology area that was first offered at Miami University in the fall of 1992. The primary objective of this course is to develop a perspective on the potential and limitations of computer science and computing technology. Topics covered include: the impact of computing on societies, models of computation, major paradigms for use of a computer, and legal and ethical use of computers. This course also exposes students to programming language and various computer tools (spreadsheets, databases, etc.).

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In the words of the Miami Plan "Liberal education involves thinking critically, understanding contexts, engaging with other learners, reflecting and acting, habits that extend liberal learning through a lifetime to benefit both individual and society" (Miami Plan, 1989, p. 10). Each foundation course in the Miami Plan must incorporate these principles. The paragraphs below introduce this course by discussing ways in which it meets these objectives.

Thinking Critically

One of the goals of this course was for students to learn to appreciate the value (and in some cases to overcome fear) of computing technology while being cognizant of potential problems as our society becomes more dependent on such technology. Class meetings were frequently devoted to discussions of the implications of computing technology on our society, and the effect of world view on our understanding and appreciation of computing technology. Examinations contained questions in which students thought critically about these and other issues. Writing assignments (such as a book report) focused on a critical examination rather than a reporting of the material. It is very difficult to think critically about these issues with no knowledge and experience in the use of computers. Therefore, students were exposed to programming and to the use of some common computer software tools.

Understanding Contexts

In this course, we discussed some common world views with an emphasis on understanding ways in which a world view can influence a person's view of computing technology; and the impact that computing technology and its velocity of change has on a person's world view. The students first homework assignment was to write an essay about their world view and how that world view has affected their understanding of technology. We also discussed the primary model in use today: the von Neumann sequential model. It was emphasized that this model affects our problem solutions and algorithms.

Engaging with other learners

Students interacted with one another in both the lecture/discussion and the laboratory portions of the course. In class, discussion was the primary teaching mode when topics of ethics, the societal influence of technology, etc. were the subject. In laboratories, students worked in small groups to accomplish the lab goals.

Reflecting and acting

Students were given opportunities to reflect on what has been learned through out the course, and to use this reflection to make informed decisions. This was one of the primary goals of the laboratory portions of the course. Laboratory assignments were not merely "cook book" descriptions to follow. Thus, student lab groups experimented with the computer, reflected on this experiment, then conducted further experiments of a more specific variety.

Importance of Lab Component

A very important component of this course was the laboratories. Approximately one-third of in-class time was spent in supervised laboratories. The students spent additional time outside of the class completing the labs. For each laboratory, a lab report was required from each group. To assure students were working on the labs and not depending on the other group members to complete labs, individual quizzes were administered at the end of each related set of labs. The lab material was included in only a general way on midterm or final exams.

The objectives of the computer labs in this course were twofold. First, the lab component was used as a vehicle to implement the objectives of a liberal education course (i.e. thinking critically, engaging with other learners). All labs were completed by teams of two to three students. In order to complete the lab, students were required to interact with other students and create a group lab report. Instead of simply following a step by step tutorial, student teams were given a task to accomplish and were required to determine for themselves the steps to accomplish that task. Such an organization forced the student to think critically, reflect, and carefully evaluate alternatives.

The second objective of the labs was to give the students a feel for the potential and limitations of computing technology via hands-on experience. Labs were designed to cover a variety of topics. In particular, depending on the section, the students were exposed to some combinations of the following: spreadsheets, electronic communications, the programming language OpenScript, the package of ToolBook, Lisp functions for turtle graphs, SQL, or a Turing Machine simulator. None of the labs provided the students with a thorough working knowledge of a package or paradigm although all of the labs provided a perspective on the capabilities of a particular package or paradigm.

Sample Labs

As described above the laboratories were developed to help meet the goals of a liberal education. Prior to each lab, the student was give a handout for the lab which consisted of the following sections: laboratory objectives (an itemized list of objectives), background (a description of the package and comments about using the package), laboratory activities (the tasks to be accomplished in task), post laboratory work (tasks to be completed outside of the in-class lab). Some of the laboratories used the Macintosh, others the IBM PC, and still others a networked mini or mainframe.

ToolBook/OpenScript

ToolBook is a windows-based application package that was used to introduce students to both software packages and programming. The primary purpose in using ToolBook was to introduce programming concepts in context. Rather than spending several weeks learning a language and then having a student write a very simple program, the intent was to expose the students to a powerful software package and then look at the computer programs behind that package. The labs required that the students look at the script behind various icons. These scripts were computer programs written in the language of OpenScript. A corresponding lecture introduced students to the fundamental programming structures and was used as a basis to compare other programming paradigms.

Xlisp

These labs were an alternate approach to exposing students to a programming paradigm. Xlisp, a public domain version of Lisp, was used with a set of turtle graphics functions to draw some simple stick pictures. This language is especially appropriate in this context because of its simple syntax. The students first modified an existing picture, then created their own. The emphasis was on experiencing the usual programming paradigm that includes the distinction between program development and execution. Some students became sufficiently interested in this process to extend their picture far beyond the lab requirements.

Excel.

Three separate labs introduced the students to spreadsheets via the package of Excel. In the first lab, students learned to enter text, numbers, and formulae, learned how to interpret an existing spreadsheet and learned to use the basic menu system of the Excel package. For the second lab, students made some more complicated modifications to existing spreadsheets, and created and printed a variety of graphs. In the last laboratory, students learned additional built in functions (such as PMT for determining payment from interest rate, amount, and number of periods), and used the spreadsheet to play "what-if" games. Students also created their own spreadsheet using the PMT function to find which bank was offering the best deal on a mortgage when loan points were considered.

Electronic Communication

During a single lab session students learned the basics of electronic mail, learned to understand E-mail addresses, and experienced various services that are available electronically, including bulletin boards, library services, and other information services. Students used a network that had been set up for the Miami community. Via this network they posted messages on a class discussion board, accessed Miami University's electronic library systems and other libraries (e.g. the Library of Congress), and used electronic services to find weather and ski conditions throughout the world. Students were introduced to the internet addressing system and were required to send the lab report to the instructor via electronic mail.

Turing Machines

In this series of three labs, students explored, modified, built, and analyzed Turing Machines. Public domain Macintosh software to simulate Turing Machines (Hannay, 1992) provided an easily used interface. The focus of this lab was on understanding an algorithmic description of a process. First, students explored existing Turing Machines as black boxes by examining inputs and corresponding outputs. Next, they explored the rules of these Turing Machines that produce this functionality, and modified them in some simple ways. Then, they constructed their own Turing Machine to implement a simple string manipulation algorithm. Finally, the lab was tied to a class lecture/discussion of algorithm analysis in which they learned to critically examine the time efficiency of some simple algorithms.

Assessment of Labs

Overall the instructors of the course were pleased with the success of the laboratories although the exercises are still in the initial stages of development. Laboratories are a critical piece to this course and the percent of time spend in labs seemed appropriate and important to the learning process.

Perhaps the most successful laboratory of the course was the electronic communications lab. Students found it very enlightening to send electronic mail to their instructor, to look up information in off-site libraries, and to check weather conditions in other countries.

One of the problems that was encountered by one of the instructors is the misconception students had about a computer science course. Some students expected and wanted to learn a specific software package in detail. They had come to understand the service courses in computer science or information systems to be skill based and some students found it frustrating to learn that the course in which they were enrolled was not skill based. Also some students were frustrated with the lack of "cookbook" style laboratories. Although teamwork lessened some of that frustration, some groups wanted more guidance than the labs provided.

In addition to the instructors' evaluation, at the end of the course students were required to complete a final liberal education evaluation. This evaluation contained 72 likert-type questions and several open ended questions. Questions especially relevant to the lab component of the course are listed in Table 1. For presentation purposes, the data for agree and strongly, disagree and strongly disagree are collapsed.

	Agree	Mixed	Disagree
I believe that my critical thinking skills have been enhanced by the laboratories in this course.	42	15	3
I believe that the laboratories of this course have provided opportunities for me to engage with others in meaningful and effective ways.	52	7	1
I believe that my ability to understand contexts has been enhanced by the laboratories of this course.	36	22	1
I believe that laboratories in this course has provided opportunities to reflect upon my learning and then acted upon what I have learned in an effective way.	43	15	2
The laboratories of this course have helped to give me a better understanding of the potentials and limitations for the use of computer science and computer technology.	47	11	2
Of all the class activities, I learned the most from the laboratories.	40	5	14

Table 1. Student Evaluations

Student evaluations indicate that the majority of students did agree that the laboratories were successful in achieving the liberal education goals of the course. Perhaps most interesting is that 68% of the students felt that of all the class activities, they learned the most from the laboratories.

Summary

Computer science and other computer related fields are faced with the daunting problem brought about by the high velocity of change in computer technology. It is important for students to have the skills necessary to use today's software tools. However, the necessary suite of skills changes rapidly. Far more important than knowledge of a particular software package is the liberal education skills that are learned in the process. Laboratories in computer science service courses can be reoriented to emphasize liberal education skills rather than a software package. The software packages are easily forgotten and quickly out-dated; but skills such as critical thinking, working with others, and reflecting should last a lifetime.

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Paper (W1-201B)

Introducing Elderly College Students to Multimedia: An Intergenerational Approach

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Key words: multimedia, intergenerational education, aging, elderly adults

Abstract

This paper describes a multimedia workshop organized by younger computer science students for 35 of their older classmates, average age 70. Results of a follow-up survey indicate that elders' responses to multimedia are positive, although older students still feel unsure about their technical abilities and may need continuing help to take full advantage of the new technology.

Introduction

The computer revolution is being coupled with yet another unprecedented trend—the aging of the American population. By the year 2000, it is expected that 13 percent of the population will be aged 65 and older. Senior citizens will comprise more than 1/5 of the population by the year 2030, when the baby boom generation reaches old age (United States Census Bureau, 1989).

This "Age Wave" is expected to impact higher education, as an increasing number of older adults return to college seeking lifelong learning experiences (Dychtwald and Flower, 1989). For example, over half of the part-time student population, which now comprises 41 percent of all undergraduates, falls outside of the traditional 18 to 24-year-old age group, with a full five percent reported as being over the age of 50 (Dembner, 1993a). Worcester State College, which enrolls over 100 elderly students each semester, has promoted intergenerational education for the past ten years and is cited as a model for this approach (Power, 1988; Stepakoff, 1993; Dembner, 1993b).

The "elder program" at Worcester State is, quite simply, the college. Older and younger students learn together in the classroom, discuss politics in the hallways, socialize over lunch, and hustle for parking spaces. Over 300 elders have taken computer courses ranging from word processing to programming to database design, and have participated in research projects involving innovative computer technology such as speech recognition and natural language interfaces (Ogozalek, Power, Hebhardt, & Perrolle, 1992).

Multimedia Technology and the Older Learner

Existing research suggests that elders are capable and enthusiastic computer users (Ogozalek, 1991). For example, Furlong and Kearsley (1990) designed a highly successful programming course for seniors and established "SeniorNet," a nationwide network for older computer users (Furlong, 1988). Other experimental studies have shown that elders can successfully use computers for tasks ranging from word processing and electronic mail to information retrieval and computer-assisted decision making (Charness, Schumann, and Boritz, 1992; Johnson, 1990; Czaja et al., 1989; Hahm and Bikson, 1989; Ogozalek and VanPraag, 1986). Surveys conducted by the AARP (Edwards and Englehardt, 1989) and the Aspen Institute (Tingay, 1988) indicate that elderly people have generally positive attitudes toward technology and want to learn to use computers .

Research involving younger adult users has shown that interactive multimedia improves information retention; people retain 10 percent of what they see, 20 percent of what they hear, 50 percent of what they see and hear, and 80 percent of what they see, hear, and do (Fletcher, 1990). Since research shows that the amount of time spent reading decreases with age, due to vision problems associated with aging (McEvoy and Vincent, 1980), a multimedia interface may lighten the load on older students' diminishing sensory abilities. A recent study in which older adults seeking medical information preferred a multimedia computer to either a printed leaflet or text-only computer interface supports this idea (Ogozalek, 1992).

The intergenerational experience at Worcester State College supports earlier findings that the graying of the college classroom enhances learning for all age groups, because of heightened levels of discussion, questioning, and, in general, a more interactive learning environment (Kay and Jensen-Osinski, 1983). Students majoring in computer science at the college have become highly sensitized to the special needs of the aging population. For example, in the computer laboratory, younger students have noticed that many of their older classmates have difficulty reading the CRT screen, especially when a small font is used.

Given the recent wave of advances in multimedia technology, computer science students were interested in seeing if this new type of computer interface could perhaps reduce some of these age-based differentials. To do this, they organized an afternoon workshop to give older students the opportunity to gain some "hands on" experience with multimedia computers. To gather data about the effectiveness of multimedia systmes, they also designed a questionnaire for the participants to complete.

The Workshop

There were 35 "official" participants who completed the survey, although nearly 100 older students stopped by to try out the computer systems. The mean age of elderly participants who completed the survey was 70 years. Sixty-three percent of the responding participants were women (mean age 69.6 years), while only 37 percent were men (mean age 70.5 years). Thirty-four percent described themselves as having "no computer experience," 34 percent as having "minimal experience (ATM, VCR, etc.)," and 32 percent reported experience with programming, wordprocessing and spreadsheets.

Twenty-five computers comprised the "Building Blocks" exhibit, which was based on the premise that participants would have a better understanding of multimedia systems if they could see the various ingredients that went into them. For example, one computer was hooked up to a camcorder which was aimed at a high traffic area; peoples' images were captured on the CRT and displayed with digitized effects. A music program allowed participants to use the computer keyboard to compose simple songs. A graphics display prompted the user for numeric input, which was then transformed into hypnotically undulating fractal images.

Two multimedia systems which fully utilized sound, graphics, and full-motion video were, by far, the most popular workstations. The Visualized USP DI, a prototype version of the United States Pharmacopeia Drug Information for the Consumer, provides visual and audio information about a drug's brand and generic names, how the drug works, which other drugs which may cause interactions, and so on. For example, rather than simply reading about the side effect of "blurred and double vision," the user sees a blurry video clip of medicines on a shelf, presumably what one would see if one were experiencing the side effect. The Name Game, created by Mindbank, is designed to improve the user's memory in a role-playing game in which the user acts as a spy. For example, the user engages in simulated conversations that take place at a imaginary party, and then, afterwards, is asked to recall the names of the various guests encountered. Helpful techniques for remembering names and faces are offered along the way.

Elders were very excited about the potential for multimedia systems, especially if they could have access to such systems at home in the way that they now watch TV. "You could press a button to ask for an antidote for swallowing poison," suggested one 81-year-old man, "and get an immediate response. If you give information about how to deal with emergencies at home, it will help the elderly to remember the necessary information."

In addition, a classroom adjacent to the computer laboratory was set up as a lecture area, where participants could watch a videotaped demonstration of the Ulysses program, a multimedia course on Tennyson's poem created by Hollywood film maker Robert Abel for IBM. The Ulysses program uses a hypertext approach which allows users to access a variety of video and film clips to enhance understanding of the poem. For example, students may choose from several different oral interpretations in which actors read the poem aloud or they may view an MTV-type montage comparing Ulysses to more contemporary heroes ranging from Martin Luther King Jr. to the Chinese man who faced down the tanks near Tiananmen Square in 1989 (Rogers, 1992).

The older students appeared to be captivated by the Ulysses program and many viewed the tape two or three times. "What a fantastic way to teach literature!" exclaimed one 75-year-old woman. "I remember reading Ulysses in high school; it was torture." The elders particularly liked one feature of the program, which provided descriptions of other forms of verse: villanelle, haiku, and even a video interview with a modern-day rapper who explains that he creates his form of poetry out of the same desire for self-expression as Tennyson. "I've been wondering what rap music is," remarked a 76-year-old man, "and I never expected it would have anything to do with a poem I learned back in high school."

Survey Results

The computer science students designed a written survey for the participants which consisted of thirty 5-point Likert scale items, as well as several open-ended questions about their workshop experience.

Attitudes toward Multimedia. Responses to the multimedia systems were overwhelmingly positive, as shown in Table 1. (Notice that the column for the "disagree" response has been omitted; there were no negative responses.)

Attitudes Toward Multimedia		
Statement	Agree	Neutral or No Response
• I think that multimedia technology can appeal even to those people with no previous computer experience.	89%	11%
• Multimedia technology can be used to help motivate students at all levels in the education system.	86%	14%
• The combination of graphics, still photos, motion video, and audio narration in these computer systems is a powerful communication method.	83%	17%
• Sound and graphics greatly enhance any computer software.	74%	26%

Table 1. Responses to survey items for attitudes toward multimedia (N = 35; mean age = 70.0 years)

Some of the written reactions include: "A great future in every field—it's in its infancy" (male, age 62); "one in every home someday" (female, age 64), and "a way of life" (female, age 75).

Physical and Cognitive Issues. Elders may experience physical and cognitive changes associated with aging—vision and hearing loss, decrease in manual dexterity, problems with short term memory and so on—which may make computers less accessible. The majority of elderly participants in this workshop, however, had no problems seeing or hearing the displays, as shown in table 2.

Physical and Cognitive Issues			
Statement	Agree	Disagree	Neutral or No Response
• I found the computer screens difficult to read.	6%	63%	31%
• The print sizes in these computers were too small.	11%	66%	23%
• The audio portions of these systems were difficult to hear.	23%	54%	23%
• It was difficult to select options from the computer menus.	17%	46%	37%
• The computer systems went too fast for me.	23%	40%	37%
• I prefer the touchscreen to the keyboard.	63%	0%	37%

Table 2. Responses to survey items for physical and cognitive issues (N = 35; Mean age = 70.0 years)

The low percentage of visual difficulties reported may be due to the fact that, whenever possible, the computer science students modified text to be displayed in larger-than-normal fonts. The lack of audio difficulties was much more surprising, given the background noise level of conversations and others computers; the combination of sound with graphic and video cues may have compensated for the noisy surroundings.

The Workshop Approach. As shown in Table 3, the workshop approach was a successful way to introduce older students to new technology. Many of the elders expressed relief that their first encounter with a computer was in a relaxed environment with student aides available to help with problems. This is consistent with Eilers' (1989) observation that a supportive environment is important for elder users.

Workshop Organization			
Statement	Agree	Disagree	Neutral or No Response
• I found it easy to meet and talk with new people at this gathering.	86%	0%	14%
• This event should be held again in later years.	83%	0%	17%
• I found the exhibits educational and intriguing.	83%	3%	14%
• These computer systems were pleasant to use.	69%	11%	20%
• It was easy to understand the language and images used by the multimedia demonstrations.	57%	11%	32%

Table 3. Responses to survey items about workshop organization (N = 35; mean age = 70.0 years)

Did the Workshop Stimulate Further Interest in Multimedia Technology? The majority of participants went away from the workshop feeling that computer and multimedia technology can play a vital role in their educational experience, as shown in Table 4.

Future Use of Multimedia Technology			
Statement	Agree	Disagree	Neutral or No Response
• Senior citizens can become as proficient with computers as the younger generation of computer users.	89%	3%	8%
• I would be interested in taking classes related to today's presentation.	66%	9%	25%
• If given the opportunity, I would like to learn how to program a computer.	57%	11%	32%

Table 4. Responses to survey items for future use of multimedia (N = 35; mean age = 70.0 years)

Sentiments more commonly associated with younger users were expressed: "The biggest problem with the computers," explained a 71-year old woman, "was that I didn't have enough time to try as many as I could." A man, 81, complained, "There were too many people; I'd like more time, without anybody on my back waiting to use the computer."

If there is any barrier that older students will face when it comes to using educational technology, it is their own lack of self-confidence when it comes to seeing themselves as capable computer users. In our statistical analysis of the survey data, the only significant interaction we found was between self-reported experience level and the statement "I would consider myself an experienced computer user," as shown in table 5.

I consider myself an "experienced computer user."

Level of Experience	Agree	Neutral	Disagree	No Answer	Total
None	0	0	11	1	12
Minimal	0	3	9	0	12

Experienced	1	6	3	1	11
Total	1	9	23	2	35

$x2 = 13.74, p < .033$

Table 5. Response to survey item I consider myself an "experienced computer user." (N= 35; mean age = 70.0 years)

A typical case is that of a 73-year old woman with extensive spreadsheeting and programming experience who nevertheless reported that her biggest problem of the day was her "knowledge of computers—I don't feel well-informed enough."

Most of these apprehensions were alleviated by the presence of more experienced users who were willing to help out. As one 84-year-old participant explained, "It was my first attempt to operate a computer; however, with proper explanation, I was able to adapt to the system." This supports the finding by Zandri and Charness (1989) that elders can reach performance levels equal to younger users, but that they will probably need more help and time to complete tasks.

Discussions and Conclusions

By creating situations in which educational technology can be encountered in an intergenerational atmosphere, both older and younger college students can benefit. In addition to the workshop approach described here, a variety of other intergenerational activities can be explored. At Worcester State, for example, the success of the workshop stimulated another group of computer science students to organize a Computer-Human Interaction seminar in which the main activity was the design and implementation of a simple controlled experiment involving input devices for elderly computer users. Recently, a partnership with a local elementary school broadened the intergenerational computer program to include the other end of the age spectrum when some elderly computer science students ran a programming class for sixth-graders.

The growing number of older students in the college population may be viewed as an asset or a liability, as an institutional problem or an educational resource. When elders encounter unfamiliar technology in the classroom, the situation can be seen as an obstacle or as an opportunity to devise new ways to increase understanding. At Worcester State College, we have found that taking the latter approach improves the educational experience for all students, young and old alike. We hope that by sharing our experience we will encourage similar intergenerational encounters with technology in all types of educational settings.

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Paper (W1-202A)

Beyond Traditional Boundaries: Coping With Multiple Intelligences in Today's Classrooms

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Abstract

Many well-intentioned teachers are working hard to teach children who fail to learn. Teachers must strive to enhance their power as educational connoisseurs and critics, professionals who understand how to use technological learning materials that carry learning beyond traditional classroom boundaries in order to promote growth across multiple intelligences. This case study demonstrates how this demand was met in a classroom in Ottawa, Canada.

From Theory

Many well-intentioned teachers are working hard to teach kids who fail to learn. That's not to be unexpected according to Howard Gardner, Professor at the Harvard Graduate School of Education and a Researcher at the Boston Veterans Administration Medical Centre. In his book, The Unschooled Mind: How Children Think and How Schools Should Teach, Gardner describes how ill-suited our minds and natural patterns of learning are to current educational materials, practices, and institutions.

Gardner explains that as disciplines proliferate and the burdens imposed upon the school increase, pressures mount to become accountable in determining student progress. Yet how is this to be done when secular schools are charged with the demanding cognitive responsibilities of presenting three kinds of knowledge across the disciplines. These knowledge forms Gardner identifies as "notational sophistication" or the mastery of written language and written numerical systems; "concepts within disciplines" or accumulation of a cluster of important concepts, frameworks, key ideas, and examples; and "forms of exposition and reasoning within disciplines" or the process of collecting evidence and reaching conclusions, an event that varies across disciplines.

Within this three-fold framework of educational responsibility lies the added burden of providing opportunities to learn to students whose abilities span seven forms of human intelligence. These forms, according to Gardner, suggest that as individuals, we are able to come to know the world (to learn) through language, logical-mathematical analysis, spacial representation, musical thinking, the use of the body to solve problems or make things, an understanding of other individuals, and an understanding of ourselves. Gardner notes that concurrent with responding to this complexity of cognitive demands and learning-style preferences, teachers are faced with numerous other social and physical limitations within any given educational environment. Being an effective teacher in any classroom is a supreme challenge.

To Practice

However, with educational restructuring and the introduction of technology into classrooms across the nation, many teachers have seized the opportunity of shifting the responsibility for learning in a manner that has led to the empowerment of learners at all levels. One such powerful learning experience, both for the teacher and the learners involved, took place at Hillcrest High School, Ottawa Board of Education. Within this setting, an "Advanced" Grade 10 English class took charge of their own learning in a manner that carried them into managing the complexities addressed by Gardner in a productive enjoyable manner. Within the context of their encounters, the students and their teacher explored language as communication (both English and French), and the content of traditional subjects such as global studies, history, science, computer technology, elementary language arts, food preparation, and music.

What follows is a description of that extraordinary curricular experience. Once described, links with Gardner's demands for a responsive, integrated, substantive, cooperative curriculum will be considered. How the Hillcrest experience addressed the needs and interests of intuitive learners (or natural, naive, or universal learners), traditional students (or scholastic learners), and disciplinary experts (or skilled learners) will be identified. Finally, the nature of the demands on the teacher within this particular pedagogical framework will be dicussed.

The learning task about to be described followed on the heels of having taught the novel Flowers for Algernon. Within that unit of study, reflecting upon the progress of Charly as he changed from being regarded as a mentally retarded young man to an intellectual genius, the Grade 10 students exhibited considerable curiosity about how we learn. Their interest sparked the design of what came to be known as the MILT.CEU assignment.

The acronym MILT was taken from Gardner's work, "multiple intelligences learning theory"; CEU was taken from the title of the computer-based learning materials Cloze Encounters Unlimited. An article in the Phi Delta Kappa Educational Foundation's PDK Fastback Series (Document #342) summarized Gardner's theory into a "multiple intelligences lessson ideas matrix". That matrix was then linked by the teacher to the power and potential of Cloze Encounters which, in its simplest form, is DOS software that allows students to work individually or in teams to create puzzles for other students to do. Within Cloze Encounters, three kinds of puzzles can be created. Within the assignment, students were free to choose which kind of puzzle they wanted to create.

The students in the class were already familiar with Cloze Encounters, having used it earlier in the year in their creative writing assignments and also in conjunction with the Shakespearean play that they had studied. It then became the teacher's responsibility to introduce new learning opportunites from an integrated, multiple intelligences perspective.

Each of the students was given a nine-page handout. The first page outlined the nature of the assignment—to be creative in designing a Cloze Encounters puzzle on any topic. The second page was a puzzle planning form. The remaining seven pages identified examples of approaches to creating Cloze Encounters puzzles that could be carried out in each of seven traditional subject domains: language arts, global studies, history, science, mathematics, practical arts, and fine arts. Within each of these subject domains, the tasks were shaped to suit learning-style preferences including verbal linguistic, logical mathematical, visual spacial, body kinesthetic, musical rhythmic, interpersonal, intrapersonal. Consequently, within the context of an explicit license to be creative, forty-two possible task designs were offered to the students. The following chart provides some examples of the sorts of choices that were included:

> Verbal Linguistic/Language Arts—Write a modern-day sequel to an excerpt from classical literature. Make the ending of that sequel the basis of a Cloze Encounters puzzle. Read the beginning of your sequel to your classmates; invite them to reconstruct the ending.

Logical Mathematical/Science—Create a puzzle that outlines the steps in the scientific method. Invite classmates to do your puzzle.

Visual Spacial/History—Create a bulletin board display that tells the story of a particular period in history. Make the content of your display clues to a puzzle that describes that period. Present your bulletin board to your classmates; then invite them to solve your puzzle.

Body Kinesthetic/Global Studies—Demonstrate a game that is popular in another culture. Invite your audience to do a puzzle based on your demontration.

Musical Rhythmic/Practical Arts—Use culture-specific music to complement your cullinary talents as you introduce a particular culture through its food. Make a recipe for an exotic dish the basis for a puzzle. Allow classmates to sample your cooking and then invite them to solve the puzzle that you created as they listen to the music you selected.

Interpersonal/Mathematics—Use a Cloze Encounters puzzle to review mathematical processes. Weave precise explanations and formulae into your puzzle. In preparation for an upcoming test, invite classmates to do the puzzle that you created.

Intrapersonal/Fine Arts—Make a reflection on personal tastes in art, music, dance, or drama the substance of a puzzle. Delete key words that identify your preferences. Invite a close friend to do your puzzle as you observe the puzzle-solving process.

Within the context of creating Cloze Encounters puzzles, there are a number of areas where students are provided with an opportunity to be creative. Not the least of these includes the chance to write a stimulating text as the basis for the puzzle, the chance to design thought-provoking verbal, graphic or concrete clues for words that come to be hidden in the puzzle, and the chance to orchestrate a dynamic introduction to the puzzle. In rising to embrace these opportunities, the Grade 10 students at Hillcrest did what their teacher considered an outstanding job. The diversity of puzzle design and the originality of thought in presentation of the puzzles provided all involved with a worthwhile series of stimulating and enjoyable learning experiences. What follows are examples of the Hillcrest students' Cloze Encounters presentations:

- Visual Spacial/History: Costume Design Through Time—Clues to missing words were provided through colourful labelled drawings on cards. Missing words referred to subject-specific jargon such as "hoops" and "bustles".The creatve text that was the basis for the puzzle involved a young woman's trip in a time machine.
- Logical Mathematical/Verbal Linguistic/Computer Science: An Introduction to Lotus 1, 2, 3—A practical demonstration of the functionality and use of the computer software contained the clues to solve the puzzle.
- Fine Arts/Interpersonal/Language Arts: A Love Poem—Two students selected a poem about a mother's love. They interpreted the poem in the form of a dance which became clues to words hidden in the puzzle.
- Verbal Linguistic/Practical Arts: A Lebanese Recipe—A taste of "taboulli" provided substance for analysis as students set out to discover the missing ingredients in a Lebanese recipe.
- Musical Rhythmic/Global Studies: The Montagnais Indians—An oral and videotaped presentation placed this aboriginal group in a cultural context. The substance of the lecture by the students and the videotape became stimuli to solving the puzzle.
- Interpersonal/History/Visual Spacial: The Halifax Explosion—This content-rich puzzle, introduced as a story, was supported solely by graphic clues, some of which were clipped from magazines, some hand-drawn, and some drawn using a graphics editor.
- Body Kinesthetic/Verbal Linguistic: A Science Experiment—Magnetic Forces—A demonstration of the effect of magnetic forces on iron filings formed the substance of this puzzle.
- Interpersonal/Intrapersonal/Practical Arts: Waffles—At once a "getting-to-know-myself" and "getting-to-know you" activity, this puzzle design revolved around getting organized to make and serve waffles.

- Musical Rhythmic/Interpersonal: Biographical Sketch of a Popular Rock Group—Collectors' cards, charades, and an audio tape provided clues to solving a "fun puzzle" on The New Kids on Block.
- Visual Spacial/Musical Rhythmic/Interpersonal/Global Studies: Comparing Our Roots in Greek and Ukrainian Cultures—Concrete clues (e.g., coins from several countries to represent the word "currency"), pictures, and music provided clues to hidden words in a text that emerged after two students interviewed each other.
- Visual Spacial/Verbal Linguistic/Language Arts/Science: Dr. Seuss Puzzle Designed for Grade 2-3 French Immersion Students—This creative effort came to be shared with students from the neighbouring elementary school, After reading aloud the beginning of an "environmental" Dr. Seuss story, puzzle creators introduced a mural they had drawn. The mural and the story that the students had listened to, along with a variety of English and French clues that had been created in Cloze Encounters, became clues for reconstructing the ending of the story that was presented as a puzzle.

Vitreous Reflection

How did what happened in this Cloze Encounters classroom reflect the substance of Gardner's demands for a responsive, integrated, substantive, cooperative curriculum? How did the MILT.CEU assignment address the needs and interests of the Hillcrest students? What was the teacher's role in this educational context? Observations relevant to these questions will now be considered.

1. Choice in Subject Matter—First, there is no doubt that the Hillcrest students seized the opportunity to become involved in a wide range of traditional subject preferences within the context of this integrated English task The element of choice in content focus within the MILT.CEU assignment was seen as significant in revealing a great deal about the students' interests.

2. Choice in Mode of Communication—How students chose to express themselves, to communicate meaning, revealed a great deal about what they believed to be their communicative strengths. Performance within these choices varied considerably, and made apparent how a teacher should direct her efforts in helping students to improve their expressive skills.

3. The Kinds of Knowledge Pursued—While engaged in creating a puzzle within a particular discipline, students were constantly involved with language as communication. Throughout the puzzle-creation and solving processes, they were actively involved in listening, speaking, reading, and writing. Not only did they strive to make sense of what would become the substance of their puzzle in order to shape that content for their particular purpose, but they were also called upon to consider how others would interpret what they wrote or represented graphically, whether it was the passage itself or the clues to words that were hidden in the puzzle. Because of this "going public" dimension of the activity, there was an intensity of purpose connected with clarifying understandings and making meaning clear.

Within the communicative choices made, and within the language used to express understandings related to the content, it became possible for the observant teacher, as an educational connoisseur and critic (Eisner, 1977), to peer through the cognitive windows that opened as students set about actively shaping their Cloze Encounters puzzles. Where understanding appeared to be lacking, the teacher was provided with the opportunity of responding to the challenge. Conferencing with individuals or small groups became an important teacher responsibility. If the content of a passage that was the basis for a puzzle was unclear, then there was room for questions to be asked. If the wording of a verbal clue was ambiguous or grammatically inaccurate, a teachable moment became apparent.

4. Working Relationships—The opportunity to work at designing a Cloze Encounters puzzle as an individual or in a small team of two or three people also reached toward meeting individual learning-style preferences. Students who preferred to work "solo" in the puzzle-creation process were granted that chance, although when it came time to do the puzzle, the balance of interactive demands was restored since involvement with others was a given.

Students who were naturally "social" and enjoyed ongoing interaction with others from the outset still had the individual responsibility of completing a learning journal after others had worked to solve the puzzle that they created. Through the process of writing the learning journal, new understandings were articulated as students reflected on what was observed as others strove to interpret clues and solve puzzles that they were presented with. Observation of their peers' search for meaning, while knowing the answers, gave puzzle creators the chance to review their communicative decisions and to see how they came to be interpreted:

- Did the puzzle challenge the puzzle solvers?
- Did any of the clues mislead them?
- Were the puzzle solvers frustrated?
- What essential background knowledge appeared to be missing?
- Did puzzle solvers stray close to a correct response but quit before reaching it?
- What assumptions did the puzzle solvers make that interfered with the communicative or puzzle-solving process?

This reflective opportunity proved to be significant in the Hillcrest learning experience.

5. Expectations and The Assumption of Responsibility—The MILT.CEU task structure allowed for learners to self-direct tasks within the puzzle-creation process, and for leaders to emerge. In this regard, it became important for the teacher to explicitly set expectations related to the development of learner autonomy, and then to withdraw somewhat, allowing time for students to take charge. It became the teacher's responsibility to schedule a certain number of classroom periods for students to engage in puzzle creation, and to inform them that this time was to be used effectively. What "effective time management" meant was also explicitly outlined.

In the cooperative forum, in addition to having emergent confusion and misunderstandings addressed by the teacher, new understandings came to be cultivated through interaction with classmates who shared the responsibility for designing "a challenging but not frustrating puzzle". The value of formative feedback was emphasized by the teacher and students were encouraged to test out ideas on each other.

By observing the nature of social interaction that became apparent in the teamwork situations, additional information about students' attitudes and abilities became apparent. For example, a student's unwillingness to challenge another student's inaccurate interpretation of a clue presented the teacher with an opportunity to discuss how a classmate's idea could be refuted tactfully. Another student's inability to get down to task and share the workload with team members led to a discussion of the concepts of maturity and commitment. Examples of how both qualities could be demonstrated emerged. A third student's inability to sequence fundamental procedures necessary for successful puzzle completion led to intervention and the introduction of strategies intended to facilitate effective planning. In cases such as these, the teacher was repeatedly presented with the chance to clarify expectations and customize facilitation procedures with regard to work and study habits and general classroom behavior. In addition, it became possible to evaluate the degree to which students responded to expectations that were made explicit.

6. Learning Materials/Task Design—Because of the technical stability and multi-directional functionality of the software itself, Gardner's "intuitive or naive learners" were able to approach the puzzle-creation task to a considerable extent in an heuristic manner that did not require strict adherence to top-down procedures dictated by a teacher. Success came to be guaranteed through ongoing built-in opportunities to review and revise what had been created to date.

At the same time, it became the teacher's job to generally outline procedures, establish timeline expectations, and conference with individuals or teams over particular puzzle designs. To facilitate this management task, the teacher designed a "puzzle proposal form" that had students outline the focus of their puzzle, (subject matter and learning-style), list the resources that they planned to use, and describe what they would do from a procedural perspective, complete with timelines. These forms simplified the process of delivering approval of student plans and scheduling final puzzle presentations.

The open-endedness of the materials' and task design also catered to what Gardner calls "traditional scholastic students" and "disciplinary experts". As were the intuitive learners, these higher-ability students were provided with opportunities to shape the creative challenge in whatever way and to whatever level of perfection they chose. This open-endedness was important since that particular Grade 10 class that included students in the 99th percentile in city-wide testing, as well as students with communication gaps and learning disabilities.

Within this mixed group, student plans involved them in gathering, setting up and operating a variety of resources, media and equipment. It involved them in managing time effectively. In other words, the learning opportunity provided students at all levels with chances to take charge of their own learning, to engage in the higher order thinking skills of predicting, planning, checking, monitoring, and carrying an idea from concept to product. Within the task structure, all students worked toward becoming autonomous learners.

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7. Approach to Evaluation—Because it was possible for puzzle designs to vary considerably, negotiating and clarifying consistent evaluation criteria with the students became another important teacher responsibility. In essence, it was determined that the following four parts of the MILT.CEU assignment were open to evaluation:

- the completeness and usefulness of the written plan;
- the manner in which students worked to create the puzzle;
- the quality of the text on which the puzzle was based
- the clues that were created for missing words;
- the effectiveness of the presentation of the puzzle to others who would work to solve it.

Within each of these areas, evaluation criteria were established, and systems for tracking/measuring performance were set up. Sometimes what was evaluated was a product; at other times, a process.

To some extent, the teacher relinquished absolute control of the evaluation process by allowing for both self- and peer evaluation to become part of the approach. For example, students self-evaluated their puzzles by writing a one-page learning journal after they had had the opportunity to observe others try to solve the puzzle that they had created. In that journal, students described what they had observed that they did not expect to see, and explained what they would change about the puzzle if they had it to do over. From a peer's perspective, students described what they most enjoyed about a particular presentation and puzzle, and decscribed how they thought both could be improved. In both cases, anecdotal comments were written and then holistically, the students assigned themselves a grade from "A+" to "C-".

Because of the scope and variety of evaluative techniques employed within the context of the MILT.CEU assignment, and because of the ongoing opportunities for getting feedback from the teacher and peers, even the weakest student's chances of success were assured. Only a student who was frequently absent or who came to the task with a totally uncooperative attitude (and there were none in this class) would not have completed the assignment in the time given.

Conclusion

It is apparent then, that within the MILT.CEU assignment, a considerable effort was made to respond to Gardner's demands for a responsive, integrated, substantive, cooperative curriculum that strove to enrich the level of understanding acquired by students. This was done in a technological milieu that provided for a great deal of choice and negotiation within a wide range of subject areas. Students were called upon to function as active responsible participants in the learning process. Their efforts were evaluated over a broad-based evaluation scheme. The teacher's role, though different from traditional expectations associated with "egg-crate classrooms" where teachers inform quiet students about what they should know, is manageable, responsive, and dynamic. It is also empowering.

The software package that provided the opportunities for the teacher to shape such a milieu proved to be equally empowering. Not only did it empower the teacher to design learning tasks that addressed a wide range if curricular complexity, but it also called upon the the teacher to actively reflect on how learning could be facilitated when the students were self-directing much of the learning process. To a considerable extent, the materials' design created a forum that promoted professional growth.

There is a great deal more that could be discussed relevant to the Hillcrest MILT.CEU assignment and how it formed an energetic response to Gardner's demands for educational change. However, it is felt that through this paper, a stimulus for discussion has been created, and the emergence of that stimulus is an adequate response at this point in time. The author would be pleased to hear from interested readers and to discuss the concepts presented here in greater detail. Now, however, closure will be brought to the description of this particular attempt at curriculum innovation.

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Additional information on Cloze Encounters Unlimited™ (or the French language adaptation, Cache-cache™) DOS platform.can be obtained from Technolinks™ Incorporated, 273 Stewart Street, Ottawa, Canada K1N 6K3 Telephone (613) 789-6716

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Project (W1-203A)

Using Multimedia and Artificial Intelligence to Teach Problem Solving

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Abstract

The technologies of Multimedia computing and artificial intelligence are potentially powerful tools for instruction, but merely applying them doesn't necessarily guarantee improved learning. In a major research effort, TRO Learning is assessing applications of these technologies to a range of instructional problems. This presentation is a "work in progress" report. It focuses on the instructional strategies for teaching problem solving to adult learners, application of these technologies to simulation-based instructional designs for teaching problem solving, including issues in the design of simulations using Multimedia, and assessment and prescription using artificial intelligence.

Key Issues in Teaching Problem Solving via Multimedia

From the beginning, the technologies of Multimedia computing and intelligent tutoring have been attractive tools for teaching a broad range of problem solving skills. This challenge has stimulated creation of many of the most innovative educational software applications. But as attractive as these technologies are, using them in a design which is instructionally effective, attractive, and cost-effective to build for a "real world" purpose such as adult literacy is not straightforward. The key instructional design problems concern definition of a learning need which can be appropriately addressed by these technologies, selection of appropriate strategies for teaching problem solving, appropriate use of Multimedia, and appropriate use of intelligent tutoring (ITS) within the instructional strategy selected.

If Multimedia and Intelligent Tutoring are the Answer, What is the Question?

If time and money were no object, it would be easy to plan a "star wars" application of Multimedia and intelligent tutoring: visions of a talking virtual reality tutor come to mind, who is capable of assessing the learner's state in real time and deciding what to do next from an infinitely large list of options. But in the real world of education, the cost of technology development and delivery must be weighed against the potential benefits to learners. For Multimedia, this requirement leads to these conclusions:

- The goal is optimum application of technology, not maximum application.
- Multimedia can be classified by level, from simple audio + still graphic applications to full-motion video and computer-generated animation with synthesized sound.
- The level of Multimedia to use should be determined by a tradeoff between costs of production and platform, time to produce, information content required for presentation and interaction, and expectations of the learners.

For intelligent tutoring, the picture is even less clear. Early large-scale intelligent tutoring systems were impressive technical accomplishments, supported by large claims and equally large budgets. But the early ITS systems often seemed to deliver less than what met the eye: instructional strategies were often simplistic, the content taught was often severely constrained, and there was scarcely an effectiveness study to be found.

More recent ITS research has avoided these excesses, but at the price of confining attention to a much more restricted set of instructional problems, learners and settings (for example, see Frasson and Gauthier, 1990). One must therefore ask what applications of ITS technologies are most cost-effective, given the state of the art. Our conclusions thus far are:

- ITS technologies are most cost-effective in simulation-based instructional strategies.
- The most critical part of the simulation for application of ITS technology is in design of learner interaction, particularly answer analysis and feedback. The software subsystem typically assigned these tasks is typically called the "Coach."
- Use of ITS technologies for construction of other parts of the simulation may be cost-effective, depending on the structure of the simulation and instructional strategy in use.

These conclusions are leading us to explore applications of ITS, and particularly the Coach, to simulations in Multimedia environments where the level of Multimedia used is controlled by the cost-effectiveness tradeoffs described above.

Strategies for Teaching Problem Solving

Earlier work on troubleshooting (Foshay, 1991) led us to the following conclusions about strategies for teaching problem-solving:

- First, teach a symbol system for use in representing the problem domain. If there exists a symbol system used by experts, it may be satisfactory.
- Then, use the symbol system to teach the state changes in the system found within the problem domain. Represent the system at an appropriate level of detail.
- Next, teach rules and system knowledge for modeling system function under all relevant states.
- Next, teach solution strategies in a domain-specific fashion (by applying domain-independent solution rules, if the learner knows them).
- Finally, teach how to derive a specific solution algorithm for problems of a specific class.

The kind of analysis implied by these principles can lead the designer to some unusual conclusions about what is important to represent in a simulation. For example, the simulation should be able to represent dynamically the state of the problem domain or system, and to provide feedback to the learner on the skill of predicting or interpreting the system state. This is true even if the representation is a high-level abstraction or if it represents system state attributes which are not actually visible or are abstract.

Two conclusions result. First, realistic simulations aren't necessarily best: what details are represented is more important than how many details. Second, the kind of representation typically seen in games is not a particularly good model for teaching problem-solving: the problem space representation typically has only one perspective (the player's current eye view); interactions tend to give up cognitive complexity and realism in order to keep the input requirements simple; and feedback is limited to results of the current move, and perhaps an overall score.

When combined with the conclusions about Multimedia and ITS, we believe these principles are directly applicable to design of a new class of intelligent Multimedia simulations which are effective, attractive, and —most important—cost-effective to build in common educational applications.

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Project (W1-203B)

Using Multimedia to Teach Program Design Concepts

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Key words: design, programming, multimedia, teaching

Abstract

A multimedia application developed with ToolBook, Guide to Program Design, will be demonstrated. This guide was designed to be a lecture presentation tool or a laboratory activity in beginning programming classes. It is intended to help teach program design concepts and techniques including the use of input-processing-output diagrams, structure charts, and action diagrams. This project also serves as an example of how multimedia can enhance the illustration of concepts being taught in the classroom. Animation allows the students to see how the computer executes a program rather than trying to imagine it with a mental picture.

The content of Guide to Program Design emphasizes the thorough development of the design of a computer program before attempting to code and enter it into the computer. A four step procedure, each utilizing different diagramming techniques, is introduced to aid in developing the plan of a program. Good programming habits are emphasized with the hopes of leading students to write well designed programs.

Animation is used to illustrate the actions the computer takes when executing a program. A wide variety of control structure and algorithm examples have been included. This animation allows the students to see exactly how the execution of the program is handled by the computer in a variety of situations.

The major topics included in Guide to Program Design are: Structured Programming, Diagramming and Control Structures, Developing the Design, and Modularization.

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Project (W1-204A)

Object-Oriented Programming with Smalltalk in School Computing—A Reflection

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Key words: programming, secondary, object-oriented, Smalltalk, paradigms, problem-solving

Abstract

This project will summarize experiences of using object-oriented programming systems (OOPS), and Smalltalk in particular, as a vehicle for teaching computer programming in secondary schools at various grade levels. We begin by

describing the motivation for choosing the paradigm, including the place that OOPS have in the evolution of programming systems, and its advantages and disadvantages as compared with more conventional approaches.

Smalltalk is an object-oriented language in its purest form. In the object-oriented paradigm problems are solved by creating software structures (objects) that contain the state (data) and behaviour (procedural code) of the components and then allow them to interact through message sending and responses among themselves. In a sense, object-oriented programming is problem solving by simulation. Object-oriented systems also make use of the idea of classes of objects which are templates from which specific instances objects can be created, but which contain the executable code for them. Moreover, classes are arranged in a hierarchy so that related classes of greater specificity (subclasses) can inherit state and behaviour from those of greater generality (superclasses). Programming in Smalltalk is carried out by extending and specializing existing classes or creating new ones, and by reusing as much existing system code as possible.

All "programming" is done by interacting with graphics windows and the mouse, cutting, pasting, augmenting and browsing system code. Nearly all the Smalltalk system is written in Smalltalk, and the programmer can see and modify any of it. There is a window-based dynamic debugging facility built in to Smalltalk that permits inspection and modification of objects during execution.

We describe how we introduced OOPS to several different groups of seniors (Ontario grade 13) and juniors (Ontario grade 11 and 12) in three different schools. Benefits and drawbacks of available texts, reference books, articles, and other support materials will be discussed. The teaching of how the OOPS paradigm functions, the importance of encapsulation in software design, navigation of the programming environment, and the language syntax itself will be described. Students coped with these ideas sometimes with difficulty, sometimes with ease, and we describe these reactions and present anecdotal comments from students on these issues. In particular, we discuss a characteristic "revolution" that we have often observed in students who have programmed in more conventional languages and systems before attempting OOPS, in which they suddenly "see the light" of the object-oriented way of thinking and programming. We also speculate on why this does not always happen with students, and on the process of students learning a second or third programming language that is different (in syntax, structure, or paradigm) from their first.

A sample of the Smalltalk applications developed by these students will be demonstrated, and we comment on the difficulties students encountered, the design and coding skills they exhibited, and on the connections that these skills have to the object- oriented paradigm. We also present a variety of student reflections on their experiences, both positive and negative.

To conclude, we outline the advantages and disadvantages, and role of OOPS in the school computing curriculum, and pose some open questions for further study.

Project (W1-204B)

C-Book: A Computer Aided Lecture Tool for the C Language

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Key words: programming, languages, computer instruction, lecture

Abstract

At the university level basic critical elements for facilitating learning are often ignored in the design and delivery of instruction. The lecture is the major medium of instruction in higher education and thus the most abused. This can be attributed to the fact that most college or university instructors are not required to have any formal training in teaching. This deficiency in the design and delivery of the lecture has contributed to the public's outcry for better and more effective instruction in undergraduate education. Lectures must be presented in an organized, consistent manner, they should be well planned and carefully orchestrated. Thus, the C-book project will address the need for improved modalities for instruction.

The C-book is a computer aided teaching tool (CAT) for instructors in an introductory C programming language course. Although C is not pedagogically suited for an introductory programming course, it is an industry standard and is becoming widely adapted as a standard for computer science curricula at colleges and universities around the country. For example, the Computer Science Department at Columbia University. The C-book project, started in 1991, was undertaken to enable the instructor to teach not only a difficult topic such as programming, but a difficult programming language, as well.

C-book was designed to help instructors improve the following elements of lecturing: organization, creation, interaction, pace and simplification. C-Book is a Windows based software that contains all lecture material for the course. It is efficiently organized in logical topics and can be easily adapted to complement many textbooks. C-book is NOT a computer-aided instructional software package. It is a teaching tool designed for instructors to facilitate the lecture method. Students can use it as a lecture review, but not as an intelligent tutorial.

Research indicates that college professors often lack structure, design, organization, and often relies primarily on oral exposition in presenting information. C-Book can help instructors to organize lecture material in an inventive, organized, and consistent manner. It is relatively easy and flexible to use in allowing teachers to customize their own lectures by selecting the appropriate pages in the sequence they prefer. The tool provides graphics and animation allowing the instructor to visualize complex lecture concepts. Related literature has shown that visualization is a highly effective pedagogical way of transmitting information, and C-book excels in this area.

Revolutionary Classroom (W1-207A)

Great Minds Need Not Think Alike

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Key words: Howard Gardner, multiple intelligences, technology, assessment, choice

Abstract

The Shrewsbury Team through a grant from the National Foundation for the Improvement in Education (N.F.I.E.) has assumed the leadership role necessary for implementing teaching strategies. Highlighted is Howard Gardner's Theory of Multiple Intelligences: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, and intrapersonal. Our grant focuses on the belief that students learn differently and that technology is an essential classroom tool. Because technology software is interactive and can allow students to explore and manipulate text, images, sounds and mathematical concepts, it lends itself to approaching different intelligences simultaneously.

Our presentation will highlight the methods we have used to assess the level of the seven intelligences in grades two, three and four. We will feature a thematic approach to learning where student choice plays a key role. Multi-media presentations using electronic encyclopedias, graphics, sound and text will be demonstrated. We will also show student databases where the emphasis on processing information is highlighted and discuss the utilization of telecommunications.

Although technology remains transparent in our classrooms, it is an integrated tool that empowers students to learn in new and exciting ways. Because Great Minds Need Not Think Alike, our revolutionary classrooms enable students to find success.

Revolutionary Classroom (W1-207B)

The Electric Connection: Revolutionizing Language Experiences in Kindergarten/Primary Classrooms

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Key words: primary, reading, writing, language, computers, publishing

Abstract

Bookmaking, immersion in language, the creation of a visually stimulating print-rich environment, puppetry, creative writing—all these time honored activities can be integrated in classrooms more easily and effectively, thanks to revolutions in both computer technology and teaching techniques. Young children are the inspiration, and computers are the "tools" that enhance classroom language experiences. Teachers and students publish exciting original books and easily create inexpensive whole language materials including Big Books, student books, mini-books and chart literature.

Participants will see how the computer can be used to easily make puppets and story-sets. They will learn how to make a uniquely designed "Story Telling Apron" that is economical and versatile. We will feature the latest in CD-ROM reading and writing software. These exciting and captivating multi-media tools read aloud to children and the magic and excitement of a specially designed word processor enables them to create enchanting original writings and magnificent computer assisted artwork.

We will share both our classroom-proven strategies for using a single computer in a regular classroom and our unique management techniques that help insure teacher and student comfort and confidence. We will demonstrate how very young students can be self sufficient with technology. Our repertoire of creative ideas and activities will allow even a novice to effectively utilize technology to enhance classroom language.

The Electric Connection

Young children are the inspiration for the revolution, and computers are the "tools" that allow kindergartners and their teacher to quickly, easily, and inexpensively "publish" delightful original books to share with a diverse and appreciative audience.

Kindergartners are "published authors," and their charming creations stand proudly in the classroom "Book Nook" for all to enjoy, are taken home to be shared, and are even shelved among the many titles in our school library. Poetry, songs, stories, and nursery rhymes can be enjoyed in large format with a group, and then become the mini-sized personal treasure of each child. Computer technology now allows the teacher to create Big Books, Mini-Books, poetry and song charts quickly, easily, and very inexpensively. This is very useful, for even though there is substantial recognition of the value of whole language experiences for young children, the cost of commercially-made materials can be prohibitive. Moreover, available selection may not coincide with classroom needs, and of course, customized and original work is impossible.

In this project, the computer is used to "publish" student books, and to make whole language materials, printed in sizes ranging from mini to huge! By using the computer to replace laborious hand lettering, materials can be made (and remade) quickly, modifications and alternative sizes are a snap, and readability is improved because of the uniformity of electronic lettering. Participants will also learn how to make a uniquely designed "Story Telling Apron" that is both economical and versatile. They will see how the computer can be used to easily make puppets and story-sets. Together these resources enrich the variety of classroom language and literature experiences.

Because it is so enjoyable, effective, convenient and inexpensive, opportunities to explore the pleasure of language are frequent and on-going. Perhaps most importantly, students really enjoy their exposure to poetry, chant, song, prose, process writing, and "layout and design." They are tremendously proud of their ability to "read" both familiar favorites and new creations to each other and to their families. This sense of "audience" has proven to be a very effective strategy for enhancing not only reading and writing skills, but enthusiasm, confidence, and self-esteem as well.

We have used the following software:

- Big BookMaker & Banner Books—Queue Inc. 800-232-2224

- Clifford's Big Book Publisher—Scholastic 800-541-5513
- Pelican Press—Queue Inc. 800-232-2224
- Super Print II—Scholastic 800-541-5513
- Wiggle Works—Scholastic 800-541-5513

Our classroom-proven strategies for using a single computer in a regular classroom and these original key management techniques will help insure teacher and student comfort and confidence.

- Coded Disk Sleeves
- Rule of Thumb
- Partners
- Licenses
- Timers
- Key words
- Medallions
- 5 Step Master Plan

New technology has tremendously enhanced reading and writing software. Exciting and captivating multi-media tools now read aloud to children. There is special software that will even will read back the child's own original writing. And the child can record his or her own voice and have his narrative take over the story. The magic and excitement of specially designed word processors enable children to create enchanting original writings and new graphics and design tools now support magnificent computer assisted artwork.

Teachers must have the comfort, confidence and skill to use computers effectively to meet their own needs as well as those of their students. Computers are the new tools for language enhancement. Computers in classrooms must becomes as natural and as commonplace as the chalkboard and books.We believe our "Electric Connection" can help teachers join a Revolution to learn how technology can truly revolutionize their classrooms.

Project (W1-308A)

Increased Student Participation in Collaborative Multimedia Systems

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Key words: video attention grabbers, multimedia, CAI systems, student participation in learning, collaborative education

Abstract

High speed computing and communication technologies have paved the way for easy collaboration between researchers in universities, industry and national laboratories, and educators and students at K-12 levels. The disparity in computational resources between hose available to researchers and K-12 educators, often prevents educators and students at K-12 from playing an active role in the development of the instructional modules. But even a simple activity such as using K-12 student supplied video clips as attention grabbers supplied video clips as attention grabbers in instructional modules can enable these students to play an active role in the development process. As a prototype demonstration, video clippings (including a child on a dog sled, cars skidding, etc.) taped from CNN live coverage of the "Storm of the Century", (the snow storm that hit

the east coast of US on March 13, 1993) were incorporated into an instructional project on Earth Sciences and Weather concepts.

Scientists at the Department of Atmospheric Sciences and at the National Center for Supercomputing Applications at the University of Illinois are collaborating with "Collaborative Visualization" (CoVis) partners at the Institute for the Learning Sciences (ILS) at Northwestern University and students and teachers at Evanston Township and New Trier High Schools. This collaboration has the support of industrial sponsors. The interactive multimedia modules (using text, audio, video, graphics, still images and animation) were developed using *HyperCard*, QuickTime video interface and other tools such as Adobe Photoshop, Adobe Premiere, Canvas, etc. Schools need only *HyperCard* and QuickTime extensions to use the programs. Students can be encouraged to videotape weather phenomena from TB and incorporate them into modules under development. The use of an easily accessible technology, i.e., VCRs, will help remove the technology disparity and enable students to make a creative contribution to the development process.

As part of the ultimate goal to design an online multimedia textbook that is accessible across Internet, interactive multimedia modules are being developed in Mosaic, a hyperlink-based multimedia database developed by the National Center for Supercomputing Applications, which allows immediate and direct access link to Internet and is available in the public domain and across many platforms.

Project (W1-308B)

The NSF/Newton's Apple Multimedia Collection: Middle School Science Education

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Key words: multimedia, interactive videodisc, middle school, life science, physical science, formative evaluation

The Newton's Apple Multimedia Collection is a Level III videodisc series for middle school life and physical science classrooms. A National Science Foundation (NSF) award of $498,000 is funding the initial development and evaluation of two Macintosh-based products (videodisc, software, and print materials), available with both English and Spanish audio tracks. Based on the Emmy award-winning PBS science series Newton's Apple , sixteen (16) video segments are being repurposed by a team of television producers, science educators, instructional designers, and software designers. National formative and summative evaluations are guiding the development of the products and will determine whether classroom use results in gains in student attitude toward and achievement in science.

The Newton's Apple Multimedia Collection is designed to supplement traditional methods of teaching middle school science. Its goals:

1. To improve student attitudes toward science
2. To improve student understanding of science concepts and principles
3. To increase the richness of science and technology instruction for under-served students
4. To expand the range of classroom tools available to middle school science teachers

A national advisory board of science education experts is guiding the 18-month effort, which includes in-service workshops at each National Science Teachers' Association (NSTA) regional meeting during 1993-1994. Middle school science teachers and students are involved in both formative and summative evaluations of the effectiveness of the videodisc, software, and print materials for each product. Both products will be ready for distribution in late 1994. Based on the results of this 18-month pilot project, a second proposal will request NSF funding to develop and introduce additional videodisc products for middle school use (e.g., physics, biology, chemistry, astronomy, technology, health and medicine, animal science, and sports science).

Formative and Summative Research:

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Society Session (W1-311A)

Aiding the Learning Process With Notebook Computers (ACM SIGCUE)

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Keywords: teaching, learning, portable, notebook, computer, special education

Abstract

New dimensions in the teaching/learning process are being revealed as educators study the effect of "portable technology" with modern notebook computers. This session will outline software and features of notebook computers that appear to enhance the teaching/learning process. Features that appear to hinder learning will also be discussed. Participants will present research findings from various projects that empathize software packages which allow students to organize and present knowledge. Recently, work has been done to use and/or develop this software with notebook computers to enhance the learning process and provide additional benefits for special education students and those in mainstream education.

The preliminary results of those studies and ongoing project plans will be reviewed. Video footage of notebook computers in use in elementary and high school settings from various sites across the country will illustrate the techniques and benefits of notebook computers as learning aids. Responses from vendors of laptop computers will also be presenter during the session to bring attendees up-to-date with features developed for the educator. Attendees will also be asked to provide information for vendor representatives on features that should be included in notebook computers for students and educators.

Project (W1-313A)

Brave New MicroWorlds

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Key words: Logo, problem-solving, multimedia

Abstract

When Logo was first made commercially available in 1981, it appealed equally to people who had a constructionist / open education philosophy and to people whose focus was high technology. For the first time, children had access to the same technological power previously reserved for software engineers

Now a new Logo environment—MicroWorlds Project builder—is dramatically changing how we think about Logo. For example, there is a Drawing Center that allows the use of drawing tools to create graphics. There is a Shapes Center where shapes can be stamped with the mouse. Therefore, children can create pictures directly without any Logo instructions (Logo commands are also available). Parallel processing is intuitively part of the environment and does not require cumbersome programming.

The question can be posed, "Are we trivializing Logo by making it easier?" This presentation will make the assumption that MicroWorlds' features free children to be more creative and, in the experience of the teacher, motivate them to explore programming ideas. Thus, it provides a rich problem-solving environment. Features such as creating multi-sized, multi-colored turtles are motivating. Having several things occurring simultaneously produces more realistic projects. Children have to deal with a variety of problems. For example, with turtles of any size, students worked at notions of relative size and perspective. A person walking away can be made to shrink (Variables don't disappear; they just are used in new situations!). A new command, glide, which takes inputs for both distance and speed, led to a discussion of how to glide backwards and thus a discussion of negative numbers.

New features means more choices which in turn means more planning. Because of the variety of ways programming can be done (procedures and superprocedures can be written as with earlier versions of Logo, or turtles may be programmed individually), children must make decisions about the final outcome of their projects. This takes a lot of pre-planning. Some problems the students encountered included: 1)If turtles are programmed individually how could they return to their starting position so that the next user would begin appropriately; 2) In what order should commands be if there is text that has to appear on the screen, an action that occurs, and music that accompanies it, at the conclusion of which the project goes on to page 2; 3) How can we make a ship stop growing when it reaches a certain size?

Learning is empowered in a multimedia environment where children can develop projects which seamlessly integrate text, graphics, animation and sound. In this environment children concentrate first on the ideas they wish to present and then on the technical issues they need to enhance their presentations.

Spotlight Session (W2-BRBA)

The Case for Learner-Centered Software in Mathematics

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Key words: functions, constructivism, mathematics education, student-centered

Abstract

Most of our current forms of mathematics instruction suppress diversity in student thought. As a result, students learn to distrust their own insights and to be increasingly passive in their learning of mathematics. In contrast, our research group has sought to create software using a constructivist perspective for teaching functions that encourages student activity and supports alternative perspective. However, to support alternative perspective, one must oneself question one's own presuppositions about the nature of mathematical expertise. Using historical work, interdisciplinary inquiry and cross-cultural investigations, we have sought to establish a broader perspective to support diversity in student voice. In this presentation, I will demonstrate examples of the diversity of student voice and discuss how our perspectives on mathematics must change to admit these voices. Using Function Probe, a multirepresentational software, and other examples still in progress, I will discuss why there is a need to create educational software that is complementary with but distinct from the current tool-based expert software on the market. How such software can be designed in relation to classroom practices will also be a topic of discussion.

Paper (W2-201A)

Development of Gender Roles: Technology as an Equity Strategy

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Key words: gender, equity, intervention, strategies

Abstract

Gender differences in computer use and attitude still exist in our classrooms. Discussion through scenarios centers on characteristics that differentiate girls from boys, development of gender roles, and factors that might be contributing to gender differences in computer use in our elementary classrooms. Intervention strategies for addressing gender differences in computer use and attitude are suggested.

Introduction

Goal Four of the National Education Goals (National Governors Association, 1990) states that "by the year 2000, U.S. students will be first in the world in science and mathematics achievement." If the United States is to remain competitive in world markets, the nation must have a technologically competent work force. American democracy cannot flourish in the twenty-first century without a scientifically literate citizenry. Thus, the achievement and participation of girls—and of boys—

from all racial and ethnic groups is a topic of considerable importance to policy-makers in business and industry as well as education. Girls, however, are steered away from the very courses required for their productive participation in the future of America. Their participation requires strength in science, mathematics, and technology—subjects girls are still being told are not suitable for them.

A survey of literature indicates that in general, teachers and schools are not yet integrating newer computer applications into the curriculum, and that gender differences in computer use and attitude exist (Thompson, Simonson, & Hargrave, 1992; Whiteside, 1992; Kiesler, Sproull, & Eccles, 1983). Reports surveyed indicate (AAUW, 1992; Thompson, Simonson & Hargrave, 1992) that girls are shortchanged in the public school system, especially in the areas of math, science, and technology and that sex and gender equity issues are still not well understood by many educators. Thompson, Simonson and Hargrave (1992) suggest that educators develop and examine interventions designed to encourage females to use technology and develop positive attitudes. These researchers also suggest that in-service training on equity issues can both increase awareness and provide specific tools for achieving a more equitable educational environment. The National Coalition for Women and Girls in Education (AAUW, 1992) has repeatedly noted that the National Education Goals cannot be met without specific attention to girls, and they have stated educators' attention must be directed to those characteristics that differentiate girls from boys. Kay (1992) argues for a qualitative, contextual, developmental approach to acquire a more precise understanding of how behaviors associated with computer attitude, aptitude, and use emerge.

This paper begins with an overview of development of gender roles, particularly in classrooms that use technology. Following this overview, observations of classroom use of technology that might effect gender equity are provided for context and discussion through scenarios. Strategies are put forth for providing an overall, positive environment for young women and young men. This paper is hopefully a means to provide thought provoking questions and continued discussion on equity issues.

Development of Gender Roles

Our society holds different expectations for girls and boys; these expectations, depending upon sex however, generate different patterns of behavior in children. Johnson and Swoope (1987) indicate that boys and girls in grades 1, 3, 5, 7, 9, and 12 showed considerable interest in computers. What factors, then, affect that interest to the point that girls don't choose to use computers as often, or as much as boys?

A study by the National Coalition for Women and Girls in Education (AAUW, 1992) indicates boys more consistently choose and prefer sex-typed toys and activities. In addition, this report finds these preferences accelerate with age throughout early childhood. By the time children are six or seven years of age, they have developed clear ideas about gender. These attitudes are based on what they see in their world. Girls and boys, then, strive to conform with gender-stereotyped roles. As a result, both sexes strongly prefer sex-segregated play groups at this age.

In the same study (AAUW, 1992), it is reported children aged eight to ten are more flexible regarding occupational roles for women and men than their younger counterparts, and there is some reduction of sex-segregated behavior. Most children of this age continue to prefer to spend time with same-sex friends.

AAUW reports (1992) that in early adolescence, more rigid adherence to gender roles becomes the norm. Early adolescence is a significant transition period for both sexes, but adolescence is a particularly difficult time for girls. At age 11 or 12, physical differences between boys and girls are particularly apparent. Large-scale empirical studies, public-opinion polls, and in-depth clinical studies following individual girls through school all report significant declines in girls' self-esteem and self-confidence as they move from childhood to early adolescence. This decline in self-esteem and self-confidence is found in the physical sciences—one critical area in which girls continue to trail behind boys. Even girls who take the same mathematics and science courses as boys and perform equally well on tests are much less apt to pursue scientific or technological careers than their male classmates. These same girls, when asked about their performance in math and science, state that they "can't do math," or that they don't understand math and science.

Why do some girls lose confidence in their abilities while so often continuing to receive high grades? "Girls learn to view their successes as caused by luck and their failures as due to lack of ability; boys learn to attribute their successes to ability and their failures to bad breaks" (Kerr, 1991, p. 128). Dweck & Gilliard (1975) discovered most teacher feedback to boys was negative and focused mainly on conduct and social behavior. Lack of effort is the usual criticism for boys; teachers consistently tell boys that they are not trying hard enough. Kerr writes that teachers' feedback to girls most often is positive, and seldom refers to effort. When girls fail at a task, teachers seldom tell them they are not trying hard enough. Thus, says Kerr, "girls do not learn to associate their effort with either failure or success. Boys learn from being told to 'try harder,' that they have control over the results of their work" (p. 128). In a conference report of this study, Kerr stated that asking a boy with a grade average of C in math how he is doing will often result in the answer "I'm doing good." Furthermore, Kerr states, asking the same question of a young women of the same age and with the same grade average, will most often result in the answer that she is not doing well or "can't do math." This is a gender gap our schools can no longer afford to ignore.

Classroom Observations

The following classroom scenarios are a composite of episodes observed by this writer in a number of classrooms in a wide variety of school settings. While these classrooms are fictitious in their reporting, observations were informal and not part of any organized research study. These scenarios described are representative of real occurrences that might contribute to technology gender inequity. They are presented here to provide context for discussions on classroom uses of technology and gender issues.

Scenario 1—Grade Two

Ms. Lewis teaches second grade—seven and eight-year olds—and has one computer in her classroom. She has this computer connected to a large screen television monitor and placed in a prominent place in the classroom as part of the large group reading circle. After reading the story Quick as a Cricket by Audrey and Don Wood, Ms. Lewis begins a discussion with her second-graders. The discussion centers around the use of descriptive words in stories, while at the same time, talking about the similes used in this book.

During the discussion, Ms. Lewis goes to the computer loaded with a word processor. She asks each student to tell her a sentence using a simile pattern, which she writes with each person's name ("I'm as __ as a __," Said __.). The similes are printed on a separate page for students to illustrate; they are then combined into a class book on similes, which will be put into their class library. While she writes each child's simile, Ms. Lewis orally describes how she uses the word processor to make changes (i.e., inserting words, saving document). At the completion of this activity, Ms. Lewis encourages Jerry to continue writing his story about his pets at the computer. The rest of the class continues writing stories from their writing folders with paper and pencil. Later, Ms. Lewis introduces a lesson on mammals. Susan and Maria are given the opportunity to use the CD-ROM in the library to find information on mammals. Children also see Ms. Lewis use the word processor to write a weekly newsletter for parents.

Throughout the rest of the week, Ann, Mario, and Felicia are assigned specific time throughout the day to use the computer to write reports on their research of mammals. Jarrod, Mary and Kris have computers at home and are encouraged to finish their reports at home using a word processor. The rest of the class will write their reports with paper and pencil. Ms. Lewis loads a word processor into the computer each morning and uses it almost exclusively during writing each day. She uses a schedule for writing at the computer, therefore, every child has a respective assigned time throughout the week to use the computer. Students with computers at home are encouraged to make use of home computers for writing. Ms. Lewis compensates that home use by varying other assignments so students are not overburdened with extra homework. For example, if Jarrod, Mary and Kris are working on their mammal report at home, they are able to use class time to work on other projects or assignments that might go home with other students.

Scenario 2—Grade Five

Mr. Rodriegez's fifth-grade class has a specific 40 minutes set aside each week to use the computer lab. These early adolescent students are able to choose any software from the wide-ranging software library available to them. A number of fifth grade boys rush into the lab ahead of their class to grab their favorite programs and to claim their computers. An observer would notice this group usually chooses the same programs while sitting at the same computers week after week. The typical program used by this group usually involves engaging graphics, a skill activity that involves manual dexterity, such as "shooting" letters from space or animals moving across the screen, or a program that has a Star Wars-type theme. They also choose to work together, sometimes in groups of four and five. They seem to enjoy this time at the computers. They are often loud and boisterous in their interaction together and with the programs they are using. The boys are usually fun-loving in spirit. There is an inordinate amount of sharing—conversations and information related to programs—between computers. As the rest of the class file into the lab, girls, usually in pairs or small groups, move quietly to shelves of software and spend time looking at title. In contrast to the boys entrance into the room, these girls continue conversations begun on the way to the lab. Eventually, most female student groups will get to a computer, begin a program, and continue their conversations. Their interaction is much quieter than the larger groups of boys, and the girls spend more of their time talking and giggling than they do on interacting with the computer.

Mr. Rodriegez has one computer in his classroom, but in contrast to Ms. Lewis's use of this sole computer, it is most often used similarly to the computer lab. Whenever anyone finishes their work, they can choose to use the computer and the limited number of games that are stored with the computer during free time. Groups are self-selected and Mr. Rodriegez does not direct software selection. Mr. Rodriegez uses the computer himself for grade-keeping tasks and occasional correspondence or student worksheets. This use is often relegated to free periods or before- and after-school hours.

Scenario 3—Grade Six

Mr. Berndt's sixth-grade science class is working on an environmental project in which students have chosen their own cooperative learning groups. Each group of early adolescents selected an area of environmental study to research in their own community. The criteria selected for completing the project include collecting data and using technology in some way to either analyze the data or to present findings. One group has chosen to photograph recycling efforts in their community, using a still camera to digitize photos. Another group will use *HyperCard* to create an informational program on an environmental topic. A third group has chosen to videotape interviews of community citizens.

Scenario 1 Discussion

Each of the above scenarios provide context for gender equity and technology discussions which follow. Children in second, third and fourth grades, approximately ages seven through ten, were reported as having already developed ideas of gender roles based on what they see in their world (AAUW, 1992). They also preferred sex-segregated play groups in the earlier years. Some reduction of sex-segregated behaviors existed, but children in the AAUW report still preferred to spend time with same-sex friends. Ms. Lewis' classroom, as described above in the first scenario, may provide a model for technology use for this age group. Here, the computer is used often as a writing tool and with frequent modeling by the teacher. Ms. Lewis' students see a female adult writing, and are aware of the benefits of using a word processor for the writing process. They see their teacher using the computer as a tool for her own work. Because Ms. Lewis is aware of who is using the computer in the classroom and at home, she is able to guarantee computer use for each of her students. The computer use is also directed in a way that fits the needs of all her students, male and female, a recommendation reported by Sanders in her Computer Equity Training Project (1985). Boys often see the computer used as a writing tool, one in which the writing process is demonstrated.

It is important that educators test the theory that using language arts-directed software at this age of interest may support both male and female student use of technology as a tool, and that such technological implementation promotes female interest in the technology field. Girls seem to be as interested in using the computer as boys, and that interest is supported by the choice of software and the time and reasons for using the computer. Do girls like writing at a computer as compared to game playing at this age? Does the modeling provided by a teacher using the computer for writing help both boys and girls develop positive attitudes towards females using technology? Would writing across content areas with six to ten year olds, especially in the math and sciences, increase girls' use of technology in later years?

Scenario 2 Discussion

In the second classroom, Mr. Rodriegez has not addressed the gender issue of computer use, and may in fact perpetuate females' choices to not use the computer. Information from the AAUW report (1992) detailed earlier tells us that early adolescence is a significant transition period for both sexes, and a particularly difficult time for girls. AAUW have reported significant declines in girls' self-esteem and self-confidence at this age. Students, when given free choice in software selection and groupings, will probably choose according to stereotypical, sex-segregated behaviors that they think are expected of them. Students will probably choose same-sex partners. "Fairly distinctive styles of interaction develop in all-boy and all-girl groups. . . the distinctive patterns developed by the two sexes at this time have implications for the same-sex and cross-sex relationships that individuals form as they enter adolescence and adulthood" (Maccoby, 1990).

There are several possible interventions that require testing in Mr. Rodriegez's and other fourth- through sixth-grade classrooms. Teachers of this age level may wish to consider asking students their perceptions about stereotypical, sex-segregated behaviors. Are women seen by this age student as having designated occupations and behaviors? Do these young men and women feel they are expected to adopt particular sex-stereotypical behaviors? This age student might well benefit from classroom presentations and associations with women and men in non-typical, as well as typical, roles (especially in technology-related fields), with roles and expectations made explicit. Should teachers of fourth- through sixth-grade students give opportunities for both teacher and self-selected grouping (i.e., cooperative learning groups selected according to abilities and/or interests versus students choosing friends)? Through self-selection, girls and boys alike may be more comfortable, but teacher-selected grouping with teacher guidance may help both genders practice this cross-grouping. One area that deserves study is software selection; should teachers select all software at these grade levels for gender appropriateness? And what is gender appropriateness? What are some of the means to determine appropriate gender differentiation? What kind of feedback do we give all our students, both male and female?

Scenario 3 Discussion

Students in Mr. Berndt's sixth-grade have been given a number of choices—who they will work with, what area of this study they will pursue, and what technology they will use to report their findings. Hopefully, these young people will see modeling of technology as a tool in those earlier developmental ages when they are more flexible regarding occupational roles for men and women, and can now make appropriate choices regarding technology use and attitude. While it is important that cooperative learning groups are determined by their teacher for many activities, perhaps it is just as important that students also choose their own groups for comfort (Sanders, 1985). Girls "do" science, math and technology equally as well as boys, and at this age it is imperative that we let both girls and boys know explicitly how they are doing. Questions for study at this developmental stage include: Are we providing role models for young women in the math, science and technology fields? What kind of feedback do we give young men and women, and does it differ between the sexes? Are we as critical of girls as we are of boys? Have we been open with students of this age as to gender inequity and their obligations as contributing members of their society as science, math and technology play greater roles?

Questions have been raised in this section for educators to discuss, pursue, and to include in research agendas. It is imperative that teachers play a prominent role as researchers as we investigate gender roles in technology use.

Interventions

Mentoring

How is it suggested that we help girls aim higher? A program at Johns Hopkins University was developed to change junior high girls' attitudes and course-taking behaviors toward careers in science and mathematics (Kerr, 1991). Normally, girls drop out of math courses early in their education. The program stressed small group and individualized instruction, and cooperative rather than competitive activities. Since girls generally focus on social careers, teachers emphasized the way in which mathematics could be used to solve social problems. Girls were encouraged to view themselves as competent in mathematics, and to overcome any "math anxiety." The program was successful in initially challenging the girls to higher achievement in math, although career interests in math dropped off. Other programs across the country offer counseling and career guidance for young women to look towards the science, mathematics, and technology fields.

Awareness

The characteristics of gender role development found in young girls to early adolescence and described above are critical in the development of technology curriculum/use in the elementary school environment. Educators need to be aware that there is a gender gap in the science, math, and technology areas. Teachers are not always aware of the ways in which they interact with students. Observations in classroom use of technology are critical. Videotaping actual classrooms so that teachers can see themselves in action can help them to develop their own strategies for fostering gender-equitable education. The use of equitable teaching strategies should be one of the criteria by which teaching performance is evaluated.

Appropriate Classroom Use

It seems that one computer classrooms in which the computer is used for rewards for finished work or game-playing can widen the gender equity gap. This author has observed middle-grade girls find ways to avoid being the first student done with an assignment so they wouldn't have to use the computer as a reward. This seems especially true if there is a game available to play that includes arcade-style graphics and "shoot-em-up" activities. Traditionally, in classrooms observed by this writer, it is often a boy who uses a computer at home, widening the gap of the "haves" and the "have nots," as well as gender inequity. Whiteside (1992) suggests two good reasons for using classroom computers for practical, goal-oriented purposes. One is that girls seem to prefer using a computer as a means to an end, while boys appear to enjoy using it as an end to itself. To encourage greater computer use by girls, therefore, we should stress school-related computer uses such as word processing, database programs, graphics and telecommunications. The second reason is that these are school computers, which presumably ought to be used for educational goals. Many children have other opportunities outside the classroom for shoot-'em-up games.

Girls and boys need to be guided in their use of technology. All children should have access to technology under conditions that suit their learning and self-awareness. Teachers may need to reexamine both the style with which they relate to girls, and the particular content areas that are emphasized when dealing with each sex. Computer use needs to be directed by teachers to provide the best learning environment: do the software programs chosen for classroom use support learning objectives? Are all children provided equal opportunities for using the computer? Are groups often teacher-selected to provide a mix of students to practice social skills, peer tutoring, and cooperative learning? If the computer is used for activities throughout the day, it is a teacher's responsibility to manage grouping and objectives for using the computer. Relating computer use to concepts already studied in class, using the computer for writing across the curriculum, and modeling of technology by the teacher as a tool are all ways of providing guidance to girls' use of technology.

Selection of Software

A question to be studied by educators interested in righting the disparity between male and female student use of computers is whether the software programs used by our students are appropriate. The following sex equity studies indicate the need for teachers to review computer programs. A study by Johnson and Swoope (1987) indicates that there is a marked difference in interest patterns when content of a computer game uses a video game format, depicted as masculine rather than feminine by students. This interpretation supports Malone's findings (1981) that girls showed little interest in using educational software materials modeled after more masculine-oriented video-arcade games. When given access to more neutral materials that did not involve shooting and war-game response formats, girls' use of, and interest in, materials increased substantially.

If girls' interest in computers is to be maintained and encouraged, the examination of software for possible sex bias should be an important consideration in software selection. Whiteside (1992, p. 254) suggests the use of a software evaluation checklist which includes the sex equity criteria: sex-fairness of activities, sex fairness of interaction (balanced versus only highly competitive), and non-sexist approach provided in the context. What we really want is to create an environment in which any student, male or female, feels free to explore his or her interests without being influenced by "stereotypical notions of 'girls' activities' and 'boys' activities" (Brady & Slesnick, 1985).

Our classroom environment must support an openness to gender differences. The traditional idea that girls are better in verbal areas while boys excel in quantitative skills is less true today. Data indicate a narrowing of sex differences in tested achievement on a variety of measures (1992, AAUW). AAUW reports, however, that a narrowing of differences is not an absence of differences—important insights can be gained by looking carefully at the continuing gender gaps in educational achievement and participation. It is important for educators to study this data further and to test in our own classrooms.

In-service and Pre-service Implications

Perhaps introducing technology to the very young, before girls identify the computer as a tool for boys, may move our young women closer to technology. The key to computer equity success in a school seems to be the willingness of the faculty to take active steps toward encouraging girls' computer use. They need to feel that computer use is valuable in and of itself, and to feel that a focus on girls is important and legitimate.

Integrating sex equity concepts into educational technology pre-service and in-service courses and workshops are necessary. Instructors' attitudes and actions in and out of the classroom must promote sex equity, as models for students' attitudes and actions in and out of the classroom. Whiteside (1992) suggests that teacher educators need to become aware of sex equity research, develop sex equity course objectives, identify sex equity course content, model appropriate sex equity teaching strategies, and provide sex equity evaluation procedures and practice. Changing attitudes cannot be accomplished through a book; face-to-face contact and interchange in a training environment are essential (Sanders, 1985).

Conclusion

Addressing sex equity requires first an awareness that we aren't meeting the needs of our young women as they prepare to become leaders in a technologically competent nation competitive in world markets. This paper has presented a review of literature addressing sex equity issues, a discussion on characteristics that differentiate girls from boys, development of gender roles, and intervention strategies for addressing gender differences in computer use and attitude. Many teachers, however, are providing modeling and equal opportunities for technology use to the girls in their classrooms. It is critical that we look for these learning environments, study and develop effective intervention strategies and then include them in teacher preparation and in-service programs.

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Paper (W2-201B)

Encouraging Enrollment and Retention of Women in Computer Science Classes

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Abstract

Women computer science students at The College of Staten Island (CSI) have a substantially higher pass rate than their male classmates; however their enrollment and retention rates are disappointingly low. Eighteen months ago we initiated a project to improve this situation. We are in the process of assembling our procedures in a kit form so that they may be easily disseminated to groups planning similar programs.

Background

While many reasons have been proposed as to why there are relatively few women in the computer science field, no one denies that there is a problem. Women make up 45% of the American work force, yet only 30% of all computer scientists are female [PP90].

The percentages in academic computer science are even lower. The 1990-91 Taulbee Survey [GM91] shows that of all the Ph.D.'s awarded in computer science in 1990, only 13% were received by women. For fourteen consecutive years, starting in 1979, women accounted for only 10-14% of Ph.D.'s. Moreover, many of these women did not pursue academic careers. Of the 137 computer science departments surveyed, only 8% of the faculty are female.

Professor Joseph O'Rourke, of Smith College, describes the decline of the participation of women in Computer Science and Computer Engineering (CS&E) throughout the length of the academic "pipeline" from high school through the professorial ranks, as follows: "Although roughly equal numbers of young women and men take computer science courses in high school, women receive about 31% of the bachelor and 28% of the masters degrees, and about 11% of the Ph.D.'s in CS&E. After a new bump to 13% at the assistant professor level, the decline continues, with the Taulbee survey data showing associate and full professor percentages in CS&E to be 8% and 4% in 1992." [OR93]

Various reasons have been proposed to explain this declining participation of women in computer science. Foremost among them is the observation of a pervasive low self esteem among young women [L90,A92]. One possible cause is the lack of positive role models at every level of schooling. Those who have succeeded, have consistently attributed their progress to their parents' and teachers' encouragement. A recent article in the New York Times describes three very successful computer scientists. "While the three women differ in many ways, they share at least one thing besides smarts: Each was bolstered early on by family and teachers who instilled in them a sense that they could do anything." [H93]. Professor O'Leary of the Computer Science Department of the University of Maryland states in a biographical sketch that her parents had high school educations, yet, "Education was a top priority in my home and my father encouraged both of his daughters to earn advanced degrees in science." She continues, "..a very dedicated teacher of mathematics got me interested in a computer project for a science fair. Her confidence in me and the doors she opened, enabled me to enter Purdue University as a mathematics major."[OL93]

In addition, many women have a perception that computer science has no social relevance. Essie Lev, a counselor in the department of Information and Computer Science at the University of California at Irvine (UCI) states, "One of the reasons we are losing students in general, and women and minorities in particular, is that we have lost a sense of passion and a sense of social relevance about what we do." [C93] Paul Young of the University of Washington comments, "Historically, women (and perhaps to a lesser extent minorities) have sought out fields, such as biology and the social sciences, that emphasize social relevance and teamwork. By emphasizing those areas of computer science and computer engineering that most require those qualities, it may be possible to attract more women (and minorities) to computing professions."

In an article for the Computing Research Association, Professor Nancy Leveson discusses the Illinois Valedictorian Project where 80 high school valedictorians in Illinois were tracked through their graduation from college. Although the women did slightly better than the men, their self-esteem went steadily down while the men's self-rating remained essentially constant. Professor Leveson reports that this project found that "the most successful antidote to women dropping out of the pipeline after a bachelor's degree was the opportunity of female undergraduates to have some successful professional experiences in terms of participating in independent research with a professor, professional employment, opportunity for interaction with graduate students and support and encouragement by a faculty mentor."[L90]

Professor C. Diane Martin of the department of Electrical Engineering and Computer Science of George Washington University chaired a research workshop entitled, "In Search of Gender-Free Paradigms for Computer Science Education." The recommendations from the workshop included: "The group recommended counteracting these obstacles with an immediate national effort at the middle-school level to develop programs appealing to girls because that is the age they lose interest in math, science and computers. ... The focus at this level should not be on programming but on the relevance of the computer to social needs ... [using] cooperative learning environments." The group charged with examining the retention issue recommended "targeting high school, college and graduate science programs. They recommended structured labs using group projects based on cooperative learning models; formal peer, faculty and alumni mentoring program for women and minority students; pairing of college students with high-school students and pairing graduate students with college students to provide positive peer role models."[M90].

Our college

The College of Staten Island is a medium-sized public institution (enrollment about 12,000) which is one of 21 colleges of the City University of New York (CUNY). This past fall, CSI moved to a new, 200-acre campus in Staten Island. Our new computer science laboratories are fully equipped with state-of-the-art computing facilities. CUNY is a commuter university which enrolls over 200,000 students. Because of its urban location and its low tuition, CSI, and CUNY, have a higher proportion of female students than most public institutions (CUNY-wide, over 60% of the student body is female). Many of the women are adults returning to school while, or after, raising families. Approximately 80% of the student body at the college are first generation college students. Staten Island is the smallest borough of New York City, with a population of slightly over 400,000. It is primarily a working class borough whose female graduates do not generally pursue careers in science. About half of the graduates of Staten Island high schools who go on to college choose to attend the College of Staten Island.

Our project

During the last year and a half women on the computer science faculty at CSI have developed two projects which were designed to increase the enrollment and retention of undergraduate women in computer science classes at the College of Staten Island. The projects, entitled "Encouraging the enrollment and retention of women in computer science courses" and "Fostering an alumnae/undergraduate relationship: a retention plan for women computer science majors," received modest funding by the City University of New York (CUNY) Women's Research and Development Fund. The projects were motivated by data which showed that while the number of our women undergraduates taking computer science classes was disproportionately low, their pass rates in prerequisite and major courses were substantially higher than that of their more numerous male classmates (see Table 1). We were particularly concerned that, while the women were doing well in their coursework, their percentage in our computer science program has been dropping (see Table 2).

Year	Males	Females	% Females	%Men Passed	%Women Passed
1988	219	100	31	51	56
1989	227	79	25	62	73
1990	189	79	29	60	72

Table 1. Enrollment in Introductory Computer Science Course (CSC 126) by gender

Semester	Number of Students	Number of Women	Percent Women
Fall 1990	115	29	25.2
Spring 1991	119	26	21.8
Fall 1991	109	19	17.4
Spring 1992	111	18	16.2

Table 2. Computer Science majors by gender

The computer science faculty at our campus has a large representation of women (one third of the full-time faculty). Three have taught here since the early days of the department (16, 20, and 21 years). One has chaired the department and two have been deputy chairpersons.

In addition to our faculty, our population of computer science graduates includes many females who are well-placed in industry, and who still live close to our campus. Both of the projects capitalized on our unusually rich resource of female role models in order to encourage undergraduate women to enroll in and complete courses leading to a major in computer science.

Some outcomes of these projects include:

- A brochure profiling the female computer science faculty and outlining some of the benefits of a career in computer science for women.
- A series of review workshops on material in the introductory computer science course, conducted by upper level undergraduate women. Evaluations from the participants indicated approval of the workshops and requests for additional workshops.
- Two seminars for potential women majors in which the department was introduced and career opportunities were discussed. At each, a different alumna of our program who is currently working as a computer scientist spoke about her career.
- A multi-user database which collects background information from the seminar participants. It was developed by two undergraduate women majors as part of this project. Software was also developed by the undergraduate women to tabulate results and to display a statistical analysis of the data.
- An "adopt an undergraduate" mentoring program for women which provides alumna role models. Its purpose is to encourage students to complete their major and provides contacts for possible graduate school or employment opportunities. Some results from an alumni survey performed prior to this project are shown in Table 3 below.
- A report detailing our recruitment and retention program will be produced this Fall. It will include information on the various seminars and workshops which we conducted.

Question	Female Percent Yes	Male Percent Yes
Employed after graduating?	100	96
Have continued studies?	80	82
Salary over $40,000?	60	52
Less than six months to find job?	90	82
CSI prepared student for job?	86	68

Table 3. Summary of Response Analysis from Computer Science Alumni Questionnaire (Numbers provided by the Office of Institutional Research. Survey prepared by Professor Moroh)

Current Projects

In addition to the projects described above to increase the number of undergraduate women majors in computer science, the women faculty are trying to encourage women to pursue graduate degrees in computer science. We are actively recruiting our women undergraduates to participate in research projects.

The women undergraduate students will work with the four women faculty members, all of whom are involved in research. Their research projects include topics in Multimedia Instruction, Expert Systems, Databases and Scientific Data Management, Algorithm Animation, and Computer Modeling.

The research projects will use a variety of computer platforms and software. In addition to the new computer laboratories, some of our faculty, including one the authors of this paper (Moroh) have received an NSF grant to set up a multimedia laboratory for undergraduate instruction in science, engineering and mathematics. The new facility will contain $200,000 worth of equipment which will be available for these projects.

In conjunction with the multimedia laboratory, we are working on four projects led by department chairperson, Professor Michael Kress. We expect these projects will appeal to those students who wish to combine computer science with the socially relevant goal of helping disabled individuals. Informal surveys have indicated great interest in these socially responsible projects among women students. The projects include:

- A three-year program to develop a calculus course for blind students using computer based multisensory assistive technology with auditory and tactile presentation of text and graphics. A grant proposal submitted jointly with the Computer Center for the Visually Impaired of Baruch College (CUNY), has been approved for funding by the NSF.
- A project to develop an American Sign Language (ASL) multimedia dictionary and tutorial station. It will be used by the Resource Center for the Deaf at the College of Staten Island. The station will enable a person to see the ASL sign for an English phrase, sentence, or word.
- A multimedia project to teach language skills to primary school age children with hearing disabilities using animated cartoons. Cartoons will be captioned in English with a window showing an interpreter signing in ASL. This project is a joint effort of teachers working with hearing impaired children in Staten Island public schools, members of the Computer Science department at CSI and the Resource Center for Deaf and Hard of Hearing Students (RCDHH) of CSI. The pilot program will be installed at P.S. 31 in Staten Island.
- A project to develop multimedia computer programs for testing and evaluation of severely disabled children are being developed in conjunction with the Board of Education and P.S. 37 on Staten Island. Computer Aided Instruction (CAI) tutorial courseware is being written as well.

Once the research projects are completed, we plan to display them at a computer exposition where all potential computer science students will be invited. Our hope is that the participating students and their peers will be inspired by the projects and the presentations and that they will consider pursuing advanced degrees in computer science.

Since the inception of our computer science program over 20 years ago, first and second level computer science courses have incorporated closed labs with the professor present to clarify and reinforce topics taught in the lecture portion of the course. Each course meets for 6 hours per week: 3 hours in the lecture room, 3 hours in the laboratory. The same instructor teaches both lecture and laboratory. Closed labs are thought to be particularly effective for teaching and have been recommended in the 1991 ACM computing curricula [A91,HA93]. Over the years, we have tried various alternative models for the lower-level courses, including one in which a different professor teaches the laboratory, and one in which there is a single large lecture section and multiple small laboratory sections. Both approaches compared unfavorably to the unified lecture-laboratory approach.

For the past three semesters female members of our faculty have been teaching at least one section of every lower-level course in the computer science major, in the hope that women will be less intimidated about enrolling in the course. We have also begun teaching experimental sections of the first few computer science courses where some innovative teaching techniques are explored, such as the use of group projects based on cooperative learning models.

Conclusion

We expect that our programs will be instituted in colleges in the New York area (specifically, our sister institutions at the City University of New York, many of whom have expressed interest in our program). We are in the process of adapting our program to the high school level, in cooperation with Staten Island Technical High School, a science and technology high school in our neighborhood. We hope ultimately to expand it to additional schools throughout the borough of Staten Island, and, ultimately to schools nationwide.

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Paper (W2-202A)

A Hypermedia Approach for Developing Research and Reporting Skills

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Key words: hypermedia, whole language, cooperative learning, multimedia

Abstract

Whole language and cooperative learning are effective ways to help students develop and integrate academic skills. The computer makes available the possibility of multimedia opportunities to apply whole language, cooperative learning, and other strategies to promote the development of cognitive, affective, and social skills.

The project reported in this paper explored a successful strategy for using *HyperCard* and interactive technology to accomplish these goals. The qualitative analysis verified that students became effective learners and communicators through the research and design process. The technology proved to be a motivator for students and increased the rate of development of basic skills as well as their knowledge of subject matter.

In addition to the written paper, this presentation will include videotaped segments focusing on key project activities and examples of children's hypermedia products.

A Hypermedia Approach for Developing Research and Reporting Skills

This paper describes and analyzes an attempt to integrate hypermedia into a dynamic classroom environment in order to promote the development of cognitive, affective, and social skills among a class of third graders. The teacher incorporated hypermedia technology into a classroom environment that emphasizes whole language instruction (Goodman, 1986) and cooperative learning (Johnson and Johnson, 1987; Slavin et al, 1983).

Hypertext is a programming concept exemplified by *HyperCard*, which permits users to move in a user-friendly, non-linear manner through text. The basic idea behind hypertext is that a reader examines a segment of text or graphic information and then can branch immediately to any one of many others segment as needed. This project permitted students to design hypertext, multimedia programs, rather than merely read a program designed by someone else.

Teachers using whole language strategies have to get used to the idea of no longer being the sole source of information and instruction for their students. Teachers must assume the role of a facilitator and an academic coach. When teachers apply hypermedia techniques as a tool for whole language instruction, the main requirement is not that the teacher must possess skills as a hypermedia programmer. Rather, the teacher must serve as an academic coach. This role requires a different type thinking than either computer programming or doing traditional lesson plans. As the teacher mirrors the process of making meaning from text, the hypermedia process evolves into reading, writing, and thinking extensions.

Description of the Class

There were twenty-one third-graders involved in this project, with abilities ranging from superior to low average. Six of these students were classified as gifted and talented (GT) in the school system. The overall structure of the class was based on the principles of whole language and cooperative learning. In science classes, cooperative groups were encouraged to focus on the meaning and results of the experiments in order to produce group reports. The writing process and instruction took place in meaningful content areas and with literature-based texts. Students were encouraged to share their work with classmates for further writing suggestions and revision.

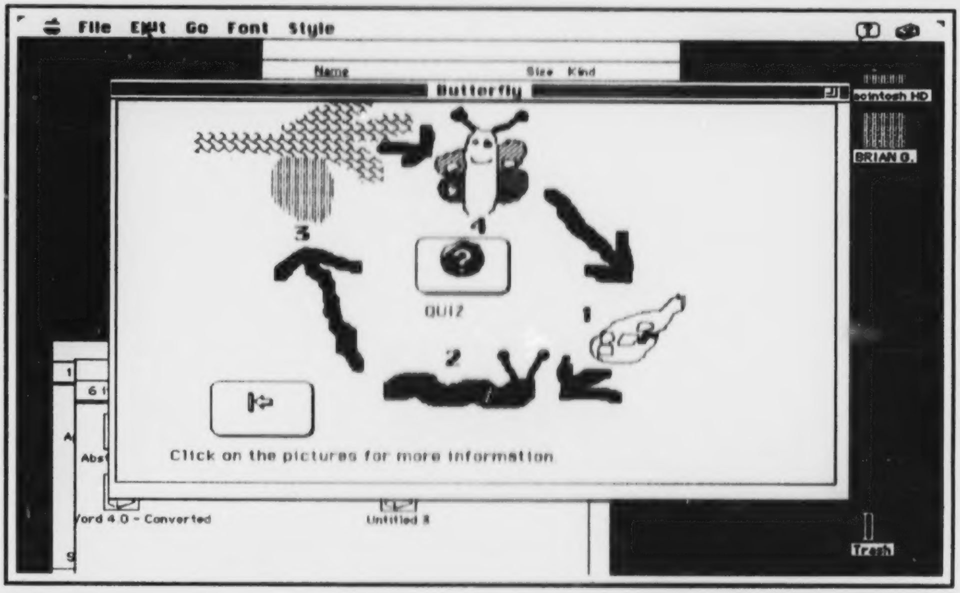
Early Stages of the Project

The early stages of this project involved getting the students acquainted with microcomputer capabilities through various software packages and introducing the students to processes of brainstorming, making a rough draft, revising, proofreading, and publishing.

Since the class was engaged in the topic of animal life stages in science, the metamorphosis of butterflies was selected for the first hypermedia project. In previous years, this was taught in a whole-language format with students reporting their findings in hardcopy manuscripts with illustrations and captions.

After touching on the topic of metamorphosis in science class, the teacher took the class to the library to gather some books and to do some investigating on the topic. At this point, she demonstrated some of her own *HyperCard* stacks and told the students that they were going to create their own software program on the life stages of butterflies or frogs in cooperative learning groups. In the form of group storyboards, the students illustrated a flow chart of how the life stages of butterflies progress. This would become their main menu.

Students were then given the opportunity to use the tool palette in *HyperCard* to create this flow chart of illustrations on butterfly life stages. During whole class lecture, the teacher demonstrated how to make a transparent button over their illustrations and link these illustrations (now invisible buttons) to new cards which would be used to type in text about a particular life stage. On the new cards, students learned how to make a field to put their text of research and findings about each stage of the butterfly's life. (See Figures 1 and 2).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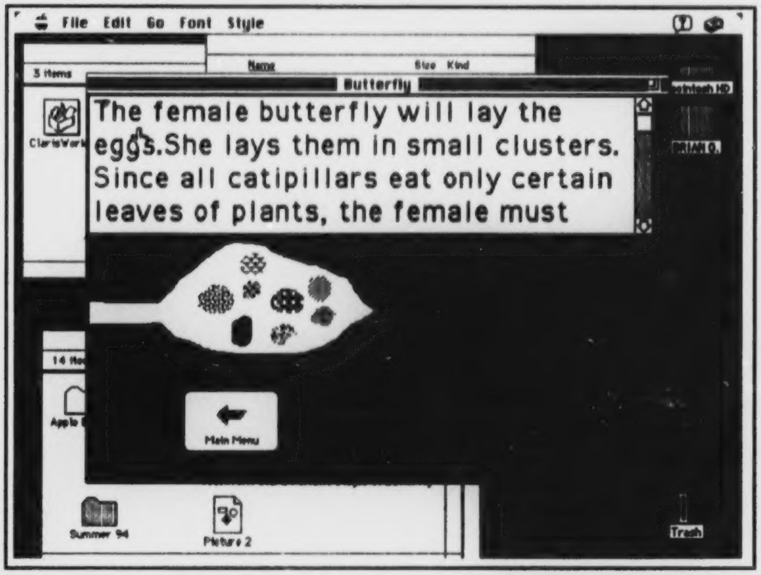
Click on the pictures for more information

Figure 1. A main menu of the life stages of butterflies. This figure demonstrates transparent buttons over illustrations. When a user clicks on these illustrations, the computer will take them to a new card that gives information on the particular life stage chosen.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The female butterfly will lay the eggs.She lays them in small clusters. Since all catipillars eat only certain leaves of plants, the female must

Figure 2. Information on the egg life stage of a butterfly. This is an illustration of what the computer would have done when the user clicked on the illustration of eggs from the main menu shown above in Figure 3.1. Notice the arrows on the far right of the text box. This is a scrolling field that indicates by clicking on the arrows, the user can see hidden text.

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Most problems encountered at this point were not major: how to make a new card, how to get back to the main menu (linking), and forgetting to grab the browse tool to continue on to cards or to type text in a field. The students relied heavily on teacher assistance at first, but soon some students began assisting others. The scholarly Brian met these tasks with little difficulty, and he found if he shared his knowledge of how to link cards with the less academically oriented Jimmy, then Jimmy would in turn share his knowledge on how he created an artistically bizarre background for his main menu card. Lisa's responsible work habits helped Kristy to stay on task and learn organizational skills. Much collaboration took place in the form of oral communication, selecting information, typing text, and adding illustrations.

The teacher next taught the students how to use the laser disc player to conduct research about butterflies and how to use the Voyager VideoStack to add interactive video buttons to their stacks.

The teacher also instructed the students to debug their program to make sure it was free of errors. She also suggested that they construct a test for other users to take at the end of their program.

Initially the students had to rely on teacher assistance for copying and pasting video buttons and scripting the audio into their stacks. However, as soon as a couple of students mastered this skill, they began teaching others. Because there was only one instructor available to answer and help with their problems, students began to help each other debug their programs. The teacher observed Greg having difficulty with his audio response; Kevin opened up the script in his own program and showed Greg his script. Greg discovered that his dysfunctional script was missing a quotation mark. Greg repaired this flaw, and his revised script worked.

The dedication of the students to complete this project was overwhelming. Pride beamed to the highest degree during the demonstration of their programs during a PTA open house.

Whales: The Main Project

Every school year, the teacher incorporates a research project on whales as an extension of the study of mammals in science. She was prepared to let the current third graders use their newly developed hypermedia skills for this project instead of the traditional paper-and-pencil, crayons, and poster boards of previous years.

The students worked in cooperative learning groups. Although the students were identified as belonging to particular groups, they worked in a non-restricted learning environment; they were able to sit in on other groups' work sessions and were encouraged to interact with other groups for borrowing and sharing ideas.

The students used planning sheets to guide them to do research on whales. Answering the questions from the planning guide became like a trivia game.They were eager to complete the planning sheets (research), so that they could begin writing their programs (reporting). The school librarian provided the students with a large number of books on whales. Numerous small group discussions as well as large group discussions took place. While walking around to observe the groups' interaction, the teacher noticed students were combing through books and magazines to come up with information for their presentations and for the questions and answers for their quizzes on whales. If she observed the majority of groups having difficulty understanding a concept, the teacher would have the class reconvene and she would lead a discussion to bring them to a clearer understanding of the concept. Groups were encouraged to seek research advice from other groups about where they might be able to locate information. Not only were they finding interesting facts and writing about them—they were also thinking of questions they would like to see addressed in their presentations and looking for answers to these questions. After the students' research was for the most part complete, the teacher instructed each group to generate a main menu and submit it for approval before beginning to write their actual hypermedia program.

Main menus (See Figure 3) are actually outlines of how the students are going to organize their report. Higher ability and average ability students continued to be comfortable with this notion of non-linear type thinking and planning. Some higher achievers almost immediately began developing sub menus. However, lower ability students continued to struggle with this notion and tended to want to make their report like a book; going from page to page without permitting the possibility that readers might want to skip around. This is one area where cooperative learning groups really promoted thinking. The higher achievers had a positive influence on average and lower-average achievers. Stimulated by the higher ability level students, some of the lower-ability students went back to their programs and recreated their programs so that they were nonlinear with main menus. As time went on, some of the lower achievers began to develop sub menus as well.

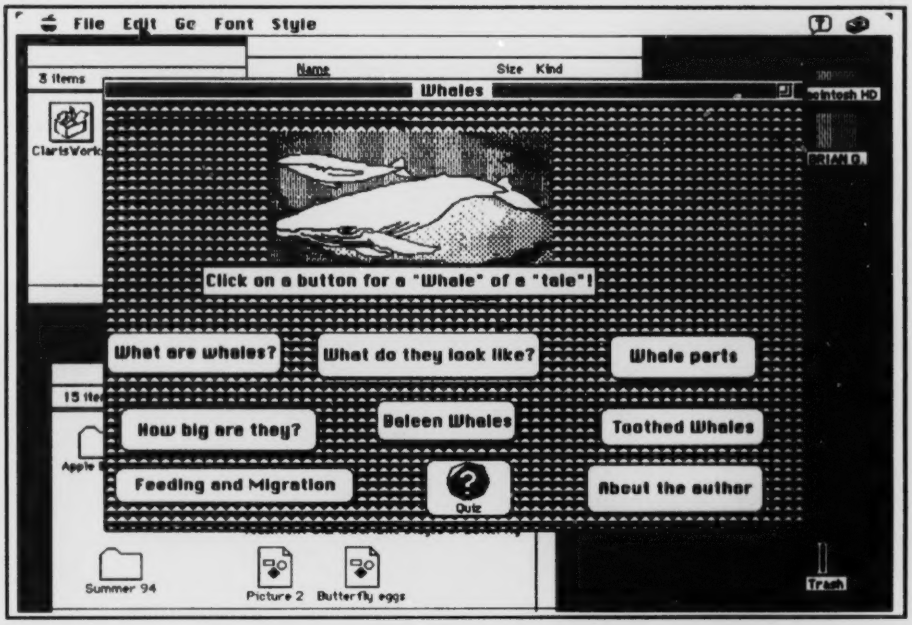

Figure 3. A main menu for a whale project. The user clicks on these buttons, and the computer takes them to the respective topic chosen and gives them a host of information. This type of organization requires the author to think non-linearly. High and average ability students are comfortable with this notion, and they help lower ability students become more comfortable with this idea.

Because these students were already exposed to cooperative learning groups in their daily class structure during other subjects, they were used to the idea of sharing responsibility. Gifted and talented students did not inhibit the performance of other students, and the GT students realized that they too could learn from other students. Adam, who is in the high average range of ability, learned how to scan color pictures from Joey, who is in the average range of ability. Erin and Lisa who have high ability levels, learned how to operate the laser video player from Kristy, who has an average ability level. On the other hand, when it came to scripting color pictures into their *HyperCard* stacks, the GT people were a big asset.

The teacher used scaffolding to promote mastery of scripting. In most cases, students would finish typing the script for their color picture and expect it to appear on the screen, and it would not. This is when they would actively seek assistance from the teacher. Each time she had to help them figure out why their picture didn't come up, or if it was following them to another card screen and appearing on that card when it was not supposed to, she gave them increasingly less help and encouraged them to try to debug the script themselves. Greg and Daven could not understand why their scanned picture of a beluga whale was not showing up on their designated card. The teacher suggested that they open the script and check the line that the computer was signaling to for debugging. This error message meant that the computer did not understand that command, and she instructed them to look for spelling mistakes, comma errors, or misplaced quotation marks. These suggestions helped them to overcome their obstacle of a missing comma, and their color picture appeared. The next time they encountered a similar problem, she asked them what they thought they should do, and they opened the script and looked for mistakes. The teacher assumed that if they ever encountered problems again (and they almost certainly did), they employ this procedure without prompting from her. Some of the GT students spontaneously took notes regarding how their finished script should look; and therefore they learned how to script without too many complications. Soon afterwards, these GT people were imitating the teacher by using scaffolding techniques to help one another. Once she saw Kristy showing someone how to make a video button, and she heard Lisa tell Kristy, "Don't do it for her. Show her how, so that she can do it by herself next time!"

When the teacher compared the students' earlier butterfly stacks with their whale stacks, she noted several interesting observations. The writing and reading, which are extensions of thinking, were much improved. Incomplete sentences and mechanical errors were almost eliminated the second time around. Part of this probably occurred because they were more proficient at the use of *HyperCard*, and they could afford to concentrate more on the perfection of their final, published product. In addition, the teacher noticed an increased level of creativity.

Generating main menus (outlines) was much easier for the Whale project than for the Butterfly project. This probably shows an increasing awareness of the logic of organizing main ideas and the use of higher level thinking skills when ideas are being presented in a nonlinear fashion (See Figures 4).

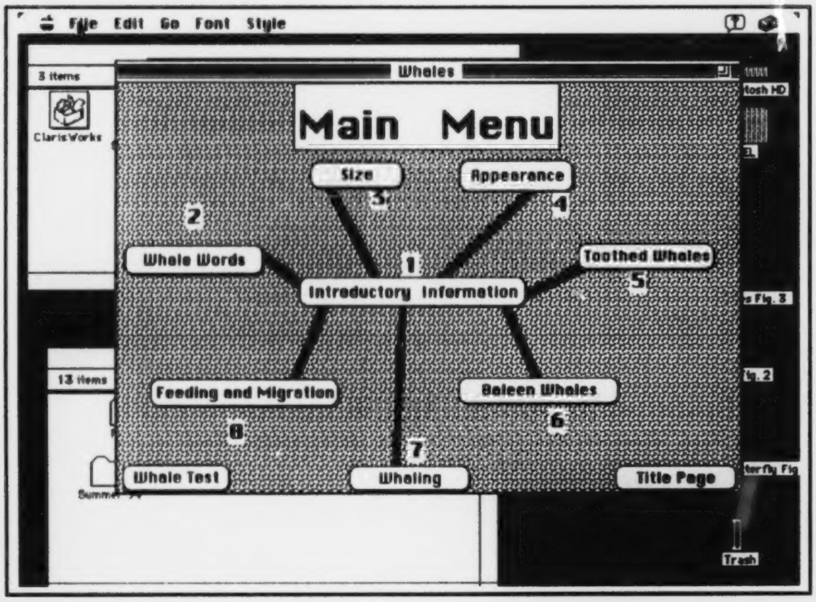

Figure 4. A main menu of a whale project (high average/average ability group). It is important to note the organization of this main menu and the fact by choosing"#2 Whale Words", "#5 Toothed Whales", "#6 Baleen Whales", and "#8 Feeding and Migration" the user is given a sub-menu of topics to choose from.

Students learned to use the laser video player effectively to step the frames in order to capture the right ones and not cut off speakers or motion in the wrong place. Full motion video provided a wealth of knowledge on the subject, and its interactive capabilities brought the students' stacks to life.

Evaluation: Comparison to Other Years

There has always been obvious motivation and excitement when the class begins an interesting, new project, such as the annual whale activity. In the past with paper-and-pencil projects, there was much excitement to begin the whale project, but the enthusiasm died toward the time to actually begin bringing the research together to write the report. This year, however, motivation and excitement were high to the very end of the whale project. Not only were the students able to generate outlines and organize materials better than in previous years, but their volume and quality of information were also much higher than in the past.

In previous years, the final product was a single, class-generated report. This year the class generated twelve different reports. Although students in the past were eager to share their newly-gained knowledge on whales, they were not as comfortable with the culminating activity of creating the report. It was difficult for earlier students to bring their project together—to generate an outline and pull their notes together in an organized manner. The teacher would take topic ideas, and the students would confirm these with their notes to generate the report. This format relied heavily on teacher direction at all times. She could not get them used to the idea of generating information on their own in a synchronized format.

In previous years the GT students did inhibit the performance of the other students. Most of the time, when problems occurred, the GT people would bail out the rest of the class. There was a tendency for the other students to let the GT students do the thinking when problems became complicated. This did not happen nearly as often this year. Because this year's

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students had generated an outline in the form of a main menu, what subject to report on next was easy for any student to identify. Because they were able to think nonlinearly, these students had a preconceived plan as to where they were going to put certain information. There were no problems as to what they were going to report on next or what to report on in the paragraphs. The teacher noted student groups talking about what information should be on certain cards and what shouldn't go on particular cards, because they had already created a button in the outline to link the information to a new card.

The teacher's own awareness of individual performance was far more personalized because she was able to spend more contact time with individual students and cooperative learning groups.

Follow-Up

The excitement of reading, writing, and thinking was still paramount to these students several months later. Before the teacher mentioned any thoughts of a new project, the scholarly Brian came up to her and told her the subject of his next *HyperCard* project. She had shared with her students an example of an electronic storybook made with *HyperCard* that incorporated imported colored pictures from a paint program, audio segments that illustrated the meaning of certain highlighted words, and some color animated scenes. The next day Joey, Greg, and Erin had manuscripts they wanted the teacher to preview so they could start their next project. The day after that, Lisa and Daven had manuscripts to read also.

Students clearly became communicators through this design process. Hypermedia with its non-linear capabilities and ability to utilize a variety of formats (for example, text, animation, still and motion video, and sound) enabled these students to employ higher level thinking skills. This technology received outstanding student acceptance, increased student attention span, increased the rate of learning for students, made organizing materials an easier task, and promoted longer retention of the subject matter. The teacher saw carryover into other subject areas and topics: writing books, science fair projects, designing new programs, etc. These hypermedia literate students need less direction with each new project they begin.

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Paper (W2-202B)

The Memory Stack: New Technologies Harness Talking for Writing

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Key words: oral language, writing, HyperCard

Abstract

An elementary school teacher describes her experiences with the Memory Stack. The Memory Stack is a *HyperCard* based tool which she designed to help her second and third grade Chapter 1 students integrate their oral language fluency into the process of learning to write.

Developing the Memory Stack

Most of my children are great storytellers. When they talk about their lives they are excited, animated, and sometimes sad, and they produce a lot of oral text. When they compose on paper, in a notebook, or even on the computer screen, those stories are often deadened; they lack the spunk and most of the substance of the oral work. Many of my children produce "bor-ring" texts —texts that seem to be labels for the ideas children have in mind, and for stories they want to tell.

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"On my birthday, I played and blowed out my candles. The End"

Before I developed the Memory Stack, I had continually sought ways to capture my children's fluency with oral language. I'd experimented with dictation and tape recorders, but found both lacking. In dictation, the listener writes. The composer simply gets to copy over the text, and never grapples with spelling, punctuation, and the other conventions unique to written language. Tape recorders work better, but young children get frustrated because they fumble around, shifting focus from operating the machine to transcribing on paper or computer screen.

My reading in the area of composition theory encouraged me in my belief that my children's oral fluency could be harnessed to help them become successful composers. Ann Haas Dyson calls oral language "the rooting system in learning to write"(Dyson, 1981). She says, "Talk is an integral part of beginning to write, providing both meaning, and for some children, the systematic means for getting that meaning on paper" (Dyson, 1981, p.783). Collette Diaute stresses the importance of talk to learning to write. She says:

> In brief, a major part of learning how to write is learning how to talk to one's self
> (Diaute, 1983, p.137)

James Britton, in speaking about the transition young children must make when learning to write says:

> ...the more the written forms resemble spoken forms at their command, the easier the transition is likely to be (Britton, 1982, p.125).

Soon after I received my two Macintosh LC computers in the spring of 1991, I discovered the wonderful potential of the microphone which comes with that machine and the audio palette available in *HyperCard* 2.0 or 2.1. (Palette is a apt name for the audio program available in *HyperCard*. It allows a child to play with sound, including the sound of her own voice as a creative medium.) I became so excited by these tools that I spent the major part of the next weekend designing the Memory Stack.

The Memory Stack is a simple *HyperCard* stack that can accommodate a voice recording, a graphic image, and a written text on the same card. When a child composes in the Memory Stack, she composes orally first, and relies on her oral language strengths to support her learning of written language. This stack is an ideal tool for capturing the lively talk-bites my kids produce each day, and bringing them into the realm of written language Together the children and I have developed a computer-age kind of "Talk-Write" program (Zoellner, 1983). The newer Macintosh technology makes this type of pedagogy a realistic option when teaching young children.

Other teachers and researchers are also experimenting with these capabilities. In her research Diaute has worked with teachers and third and fourth grade remedial students in a genre she calls "Multimedia Composing." Her work emphasizes children's strengths with "nontextual media" including the "living media of social interaction and talk" (1992, p.251).

In this paper I describe my experiences teaching and learning with the Memory Stack; I detail how the children and I use it in our daily work, and I suggest how this type of pedagogy can be developed further for use in diagnosis of language problems and in assessment of language development.

Using the Memory Stack

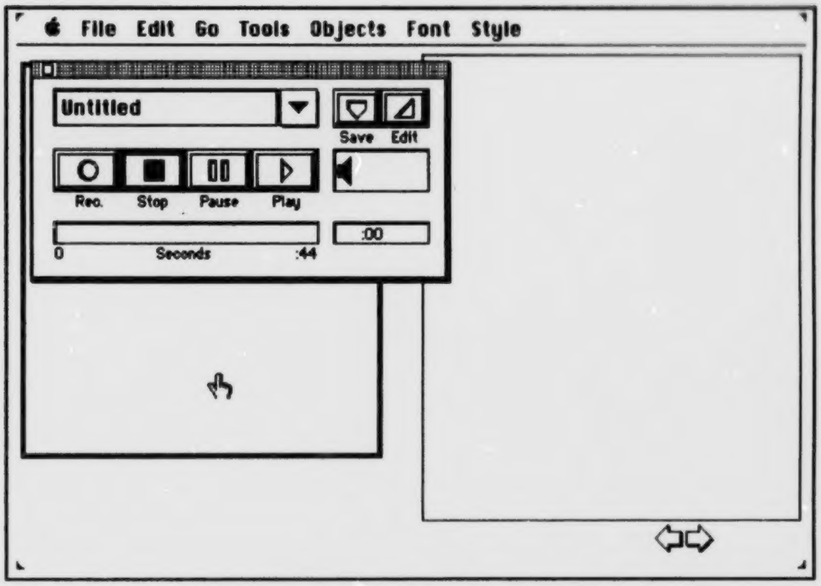
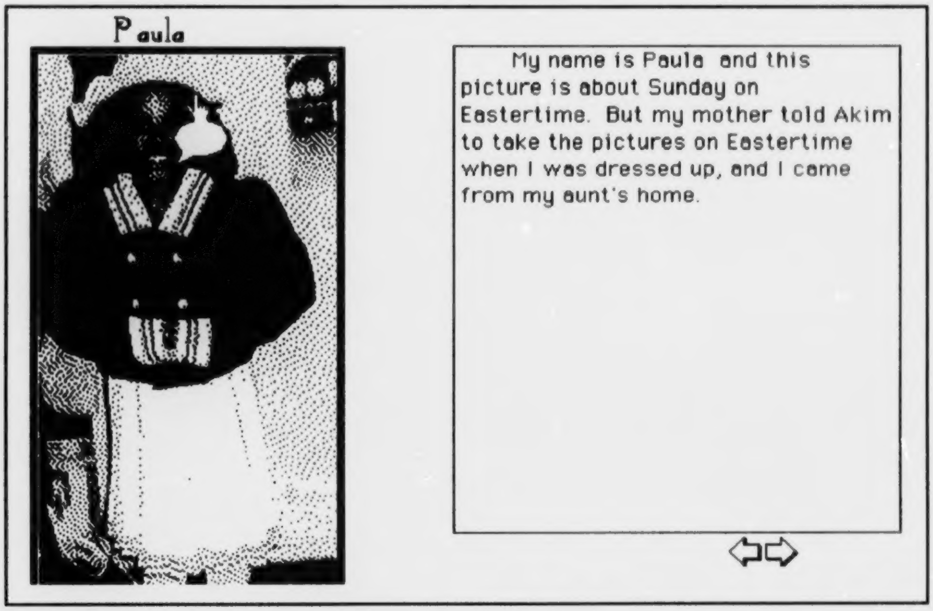


Figure 1. The Memory Stack Card

Using the Memory Stack is easy. Children tell their stories into the microphone, save them, and then play them back a few words at a time using the "Pause" button to navigate through the oral language. Then they move the mouse to the text field side of the card, click on it, and transcribe their texts. They returns to the audio palette, play a few words more, and go back to the text field to continue transcribing. Some children do all their work in one sitting. For others, it is easier to work on their transcriptions a little at a time. It doesn't matter how a child chooses to work because the children's oral language is always there to support them whenever they return to work on their cards. (One of my second graders explained the name of the Memory Stack to a classmate in this way; "It's called that because it remembers your words for you.") When the transcription is complete, we print out the cards and place them on construction paper backings for display. Often kids want to make five or six copies for parents, aunts, teachers, friends, etc.

We actually began referring to this stack as the Memory Stack because the first project we did with it was a simple multimedia project on memories. I asked my children to bring in photos that made them remember events, people, places or things that were special to them. Using HyperScan, a simple program that comes with the Apple Scanner, I scanned the photos and pasted them on to cards in the stack so that each child had an individual card. Then, using the audio palette, the children taped their memories. If the picture was a photo of the author, I saved the sound with a button which looks like a comic strip bubble. I placed the bubble on the mouth of the speaker. When the button was "clicked on" by the mouse, the picture of the speaker seemed to tell the story.

Finally, the author transcribed the oral text into a text field which was placed next to the photo on her card. This is the memory card which Paula, then a third grader, made in the Spring of 1991.



Paula

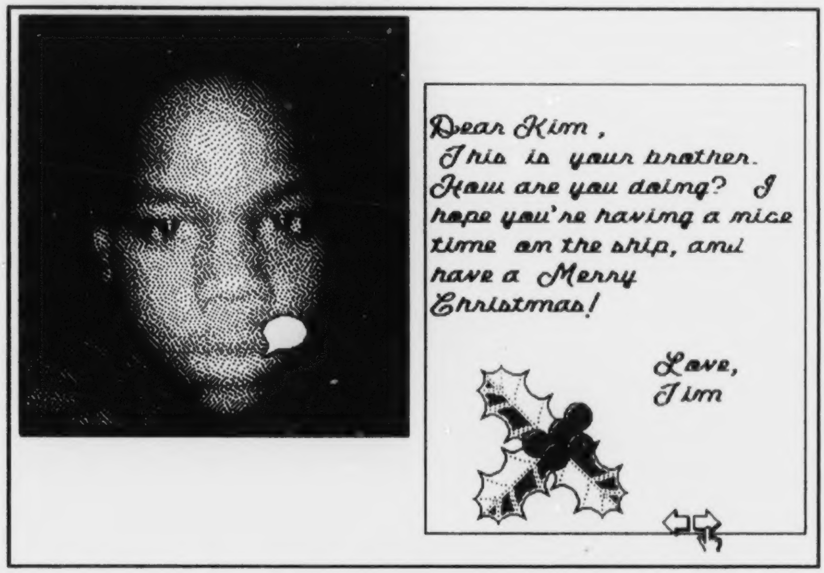
My name is Paula and this picture is about Sunday on Eastertime. But my mother told Akim to take the pictures on Eastertime when I was dressed up, and I came from my aunt's home.

Figure 2. Paula's Memory

Just before Christmas 1991, I decided to use the Memory Stack for what I called our "Gifts of the Magi!" project. This was related to our school's Spanish as a Second Language Program's study of the cultural significance of the Three Kings. The children in this program make presentations and bring gifts on January 6th to all the classrooms in our school, so "Three Kings Day" has become a school-wide winter celebration.

We talked a great deal about gift-giving, and especially about gifts that can't be bought—like the long journey that each king made to see the infant. We talked about a gift as a means for one person to honor another. I asked my third graders to think of people who were special to them; people whom she would like to honor with a gift of her writing. I took a Polaroid snapshot of each child, scanned it with HyperScan, and pasted the photo onto a card in the Memory Stack. The children recorded messages to their special person, and transcribed them. Since these were to be final published products, I had an editing conference with each child to "clean-up" the transcriptions. Children, who wished to do so, added Chanukah and Christmas clip-art to their cards. Two of the children taped their messages in two languages, one child in Spanish and English, and another in Chinese and English. Unfortunately, neither child felt confident enough to try to write in her native tongue, so we only have the oral versions in the first languages. We printed three copies of each one and mounted them on red, green, or blue paper. One was sent as a gift, one became part of our "Gifts of the Magi" display, and one was for the author.

Tim, whose older brother is in the Navy and was unable to be home for Christmas, created the card below. He felt his brother's absence deeply, and creating his card helped to deal with those feelings. He was very proud of this card. I'm sure his brother was honored!



Dear Kim,
This is your brother.
How are you doing? I
hope you're having a nice
time on the ship, and
have a Merry
Christmas!

Love,
Tim

Figure 3. Terry's Gift

Teaching with the Memory Stack

When we fist created the Memory Stack, I thought of it as a tool to be used with children like Paula and Tim, children who already had reasonable facility with invented spelling. Barry Kroll speaks of three phases of the writing process which were useful to me when I was thinking about what I wanted to accomplish with the Memory Stack. He speaks of the "preparation phase," the phase in which children are still acquiring the "technical skills necessary to create symbols for speech," the consolidation phase in which children can relate speaking and writing so that writing skills "become progressively strengthened by drawing on the generally more mature language resources" and the "differentiation phase" when children understand that writing and speaking differ in style and function (Kroll, 1981, p.39).

Initially, I saw the Memory Stack as a tool to move children from the consolidation phase toward the differentiation phase. One of my teaching goals in designing the stack was to create a medium in which children could accomplish written language tasks independently, relying only on their own oral language for support. When Paula transcribed her Easter piece, and Tim his Magi piece, they worked independently , drawing on their "more mature (oral)language resources."

My work with a special group of three second graders during the 1992-1993 school year taught me that the Memory Stack could be used with children who are in what Kroll calls the "preparation phase"—with terrific results. Dion, Pat ,and Laura were all experiencing extreme difficulty acquiring the technical and linguistic skills necessary to relate symbols to speech All three of them had such great gaps in their knowledge of sound/letter correspondence that they found invented spelling frustrating. In September, two of these children were lacking a significant number of reading readiness skills. The third was struggling with one syllable sight words. For them, "creating symbols for speech" was frustrating and arduous work.

In February, I decided to use the Memory Stack with this group of three children for three reasons. (a) I wanted to see how well they could adapt to this kind of technology based instruction; to see if the computer motivated any of them. (They loved games and skills software that functioned like games.) (b) Because they were already in the middle of grade 2 and experiencing such great difficulty, I wanted to give each of them a chance to be successful with language: an opportunity to write a whole text with minimal frustration and tangible rewards. (c) I also wanted to get some insight into how these children conceived of narrative; I wanted to see how each of them structured the telling of a personal tale.

Using the Memory Stack with these children was rewarding and revealing. Each time I sat with a child at the computer, I learned something about each child as a composer, and as a reader and writer of text. Along the way, I discovered that the Memory Stack is a wonderful tool both for teaching phonics out of whole language and for assessing the linguistic strengths of beginning readers and writers.

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Dion

Dion is a bright-eyed extremely affectionate seven-year -old second grader. His academic difficulties are compounded by emotional difficulties. One morning as I was greeting the children as they entered the building, Dion grabbed my hand and proceeded to tell me all about finding a dog which his grandma said he could keep. He was very excited and the language rolled off his tongue in a cohesive story which I could follow. Dion had never written a story like that. He would become so frustrated after writing the first line or two of a piece that he would cry, and the story wouldn't get done.

Later on that day, he came to my Chapter 1 class in the Mac lab. I asked, "Dion, Could you write about your new dog. "

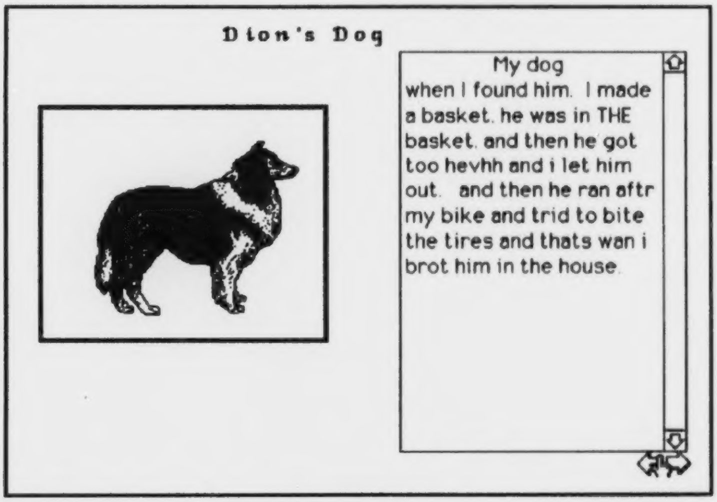
> He wrote:" I hav a new dog."
>
> I said, "Dion, I want the story you told me this morning about the dog chasing your bike."
>
> He said, "I can't write all that!"
>
> I asked "But can you tell the story to the computer just like you told me."
>
> He said, "Sure, I can do that."

We sat down together at the LC. I found a "clip-art" dog file, and we copied the dog he chose from that selection. I opened the Memory Stack, pasted in the picture of the dog, and Dion recorded his story. Then we sat down together to transcribe. I showed him how to use the play and pause buttons on the audio palette, and he went to work. We worked together on sounding-out the words and he hit the keys on the keyboard—oral, visual,and tactile— all the modalities, all at once; working holistically from a complete text. This interaction naturally combined so much of what makes for a rich learning experience.

We continued to slowly grapple with his language, and he became more excited as he made his speech become text. Dion loved to form the "ou" sound with his mouth, and reveled in that sound as he typed the letters "o" and "u." He had no difficulty with long vowel sounds. He knew where he wanted to put in periods.

Dion is fairly logical in his organization of narrative. He began his taping with his title "My Dog." Then he proceeded to tell his tale chronologically. He finds a logical ending for his narrative by simply putting his dog in the house. Dion also has a sense that written language has to be proper. He taped that he "brung" his dog into the house, but when he was transcribing, he said, "Brung ain't right." I said that the proper word was "brought," and so he wrote "brot."

We spent some part of two more periods on his text, and when he finished, he was extremely proud of himself, requesting copies for his teacher, his grandma, and his cousins. This is his finished product.



Dion's Dog

My dog
when I found him. I made a basket. he was in THE basket. and then he got too hevhh and i let him out. and then he ran aftr my bike and trid to bite the tires and thats wan i brot him in the house.

Figure 4. Dion's Dog

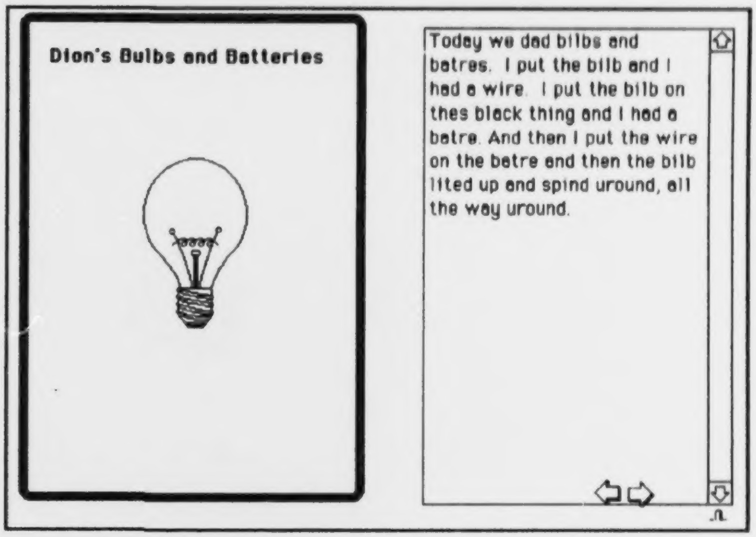
Later on this past spring, I offered children opportunities to publish bound books in multiple copies for the Young Authors program. I told them they could use a journal entry, a story they had already written, a book they made earlier, a Memory Stack entry, or they could write a new story. I really did not expect Dion to want to participate, but he surprised me. He asked if he could make a book from his "dog story."

We opened the Memory Stack and copied the text into a word processor. I told Dion that he would need to edit his story so that spelling and punctuation would be correct, to make it easier for a reader to follow his words. He read it to me, I asked some questions, and Dion edited his story. We divided it into pages and printed it out so that Dion could draw his illustrations. Dion's Dog was a "picture book" selection on our Young Author's list.

This method is a terrific way to compose personal experience stories, because the sequential framework that such stories take make them easy to tell. But my experiences with Dion taught me that this method is also useful for more transactional kinds of narratives.

Dion's class did a great deal of hands-on science. On one particular day when I went to pick him up, his teacher said, "We're keeping a science journal on our experiments. Today we worked on bulbs and batteries, and I can't get Dion to write one sentence in his journal."

I took Dion back to the lab, and we sat down at the keyboard. He was dejected and disappointed in himself because he knew that his teacher was a bit irritated with him. I went into a clip-art file and found a drawing of a light bulb to motivate him; to show him that he could have the best journal page in his class if he produced it on the computer. We copied the light bulb into our Mac scrapbook and opened up the Memories stack, and pasted it in on a new card. I opened the audio palette and handed Dion the microphone. I said, "Tell the computer what you did today with bulbs and batteries." He happily recorded his journal entry. He knew exactly what he had done with bulbs and batteries. He transcribed his whole entry in one sitting—remaining with me into his lunch period to do it. We printed it out, and he came back after lunch to pick up three copies. I had to stop him from running to his classroom with his work. That was a real triumph for him, for me, and for this method of composing.



Dion's Bulbs and Batteries

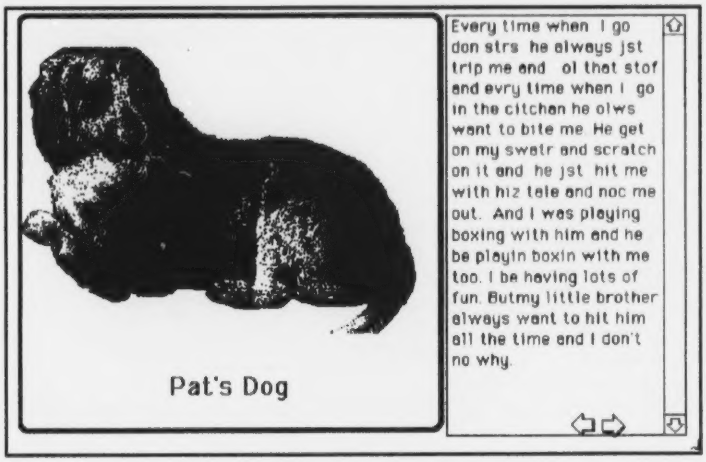
Today we dad bilbs and batres. I put the bilb and I had a wire. I put the bilb on thes black thing and I had a batre. And then I put the wire on the batre and then the bilb lited up and spind uround, all the way uround.

Figure 5. Dion's Bulbs and Batteries

Pat

Pat came back to second grade in the fall with very few reading skills. He was not sure of many of the initial consonant sounds, and he certainly could not work with vowels. Pat is an extremely impulsive seven-year-old. He'll jump up and run across the lab if he hears an appealing beep. He doesn't realize he's doing it, so it is very hard for him to control himself. Pat is very sensitive, and becomes extremely hurt if an adult attempts to point out his behaviors to him. In short, he is a difficult child to teach.

Not wishing to be outdone by Dion, Pat wanted to tell me about his dog. He didn't have a picture of his dog so he too chose a clip-art dog which he said looked like his dog. We pasted it on a card in the Memory Stack, and Pat taped his tale. He produced so much language that we needed to make two buttons on his card to save it all, stopping in the middle. We played back the first half, and then he continued composing the rest. Pat had never before composed more than one sentence on paper or on the screen. He easily became extremely frustrated and alienated from the experience of writing. But, it turns out, he had a lot he wanted to say. This is Pat's story.



Every time when I go don strs he always jst trip me and ol that stof and evry time when I go in the citchan he olws want to bite me He get on my swetr and scratch on it and he jst hit me with hiz tale and noc me out. And I was playing boxing with him and he be playin boxin with me too. I be having lots of fun. Butmy little brother always want to hit him all the time and I don't no why.

Figure 6. Pat's Dog

Pat was daunted at the thought that he might have to write all those words. I explained that he could do a little at a time until he finished. And he did. I sat with Pat a good deal of the time and took notes while we worked. I was learning so much about him! I found out which sounds he needed help with before he could attempt an invented spelling. I began to understand how much he depended upon sight vocabulary. As we slowly sounded words out together, he typed the letter he thought went with the sounds we were making. I learned that Pat could remember something he had been taught at one point and forget it on the next line as with the "ing" ending in the word "boxing." I found that he knew a rule he had been taught. He said, "time puts an 'e' if the 'i' sounds like that;" I also found out that he could not apply the same rule to a words he could not spell by sight. I reminded him of the rule so that he would discover that he could spell "bite" correctly.

I learned that Pat organized his thoughts for this piece by excitement level, moving from "tripping" to "biting" to fighting in the kitchen to playing "boxing." He ends his piece in a rather poetic way, moving from his relationship with the dog which he understands to his confusion about why his brother always wants to hit the dog.

The most important thing I learned was that Pat could produce a good deal of text even though he has severe language problems. The most important thing Pat learned was that he could write his own story! This method was extremely liberating for him and for me.

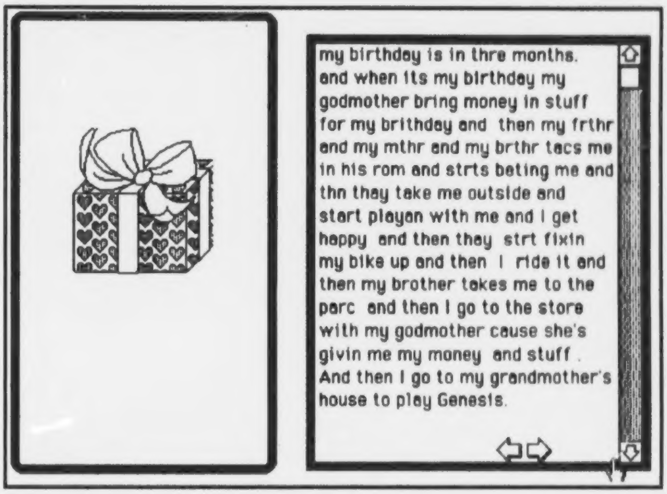
Laura

Laura is a bouncy seven-year-old. In fact, she has very little attention span, even when it comes to computer games. She spends barely two minutes on one, and she asks to move to another. She cannot focus long enough to become involved in an activity so that it becomes interesting. She was a non-reader in September.

Laura wanted to tell the computer about her birthday, and she too created a prodigious amount of text for a seven year old with language problems. As Laura worked on her transcription, I learned that Laura was missing basic short vowel knowledge, and also had difficulty with "r -controlled" vowels. She could not hear the sound of "o" in mother or the sound of "a" in father, but she knew the "ou" sound and could spell "outside." She was able to deal quite well with long vowels.

Like Pat, she was very excited when she taped her piece, and that excitement is clear in the tone of her voice. She said that her birthday was in three weeks, probably because she "couldn't wait." But when it came time to transcribe her piece, she changed weeks to months. Like Dion, she seemed to have a certain respect for the truth of the written word, and she was a bit awed by her own story as it became print— a "real writer's experience." "I can't write weeks; that's not right; it's months." And so she wrote "months." Janet Emig refers to this phenomenon as the "aura" around the written word which she contrasts to the "mundane" nature of talk.(Emig, 1981,.p.87)

Laura organized her piece sequentially, as she remembered the sequence of events that made up past birthdays. The excitement in her oral voice, comes through well in the written voice. The reader is pulled along with her from one activity to the next until we all collapse in front of the TV at her grandmother's house to play Genesis.



my birthday is in thre months.
and when its my birthday my
godmother bring money in stuff
for my brithday and then my frthr
and my mthr and my brthr tacs me
in his rom and strts beting me and
thn thay take me outside and
start playan with me and I get
happy and then thay strt fixin
my bike up and then I ride it and
then my brother takes me to the
parc and then I go to the store
with my godmother cause she's
givin me my money and stuff .
And then I go to my grandmother's
house to play Genesis.

Figure 7. Laura's Birthday

Children Define a Memory Stack Project

Word of the "talking computer" spread through the second grade, and two boys in Pat's class, Sam and Andrew, asked me if they could use the computer to tape their rap. I said, "OK, but you have to type the rap after you tape it and make a picture to go with it. Both boys thought that was a pretty good idea. Sam did the drawing, and Andrew taped the rap. They even put in sound effects, made by mouth that they couldn't transcribe, although Andrew tried. Not being a Rap aficionado, I don't know if their rap was original, but that didn't matter to me. What mattered was that two little boys, completely on their own, worked together to create a whole piece of publishable work. They demanded that I check the spelling and "fix it up." They wanted it to be right, and they wanted many copies to distribute. This is the final product, "D. Swift's Rap."

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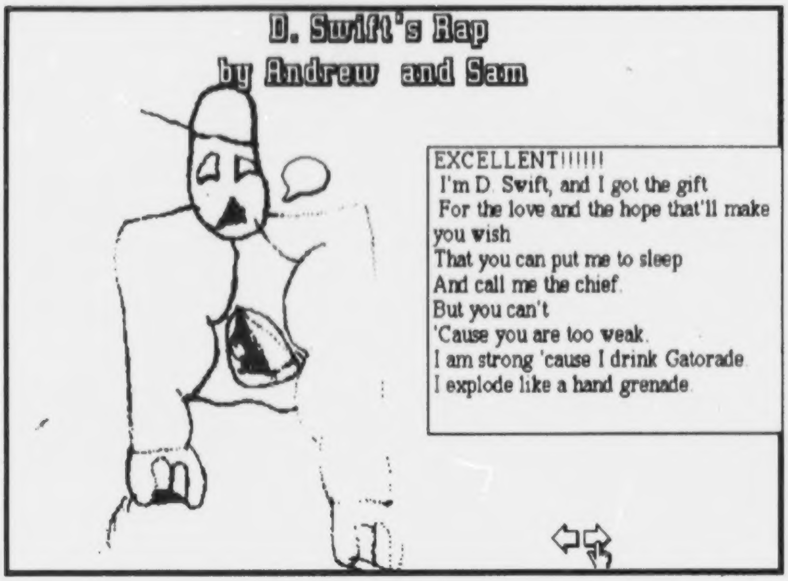

D. Swift's Rap
by Andrew and Sam

EXCELLENT!!!!!!
I'm D. Swift, and I got the gift
For the love and the hope that'll make you wish
That you can put me to sleep
And call me the chief.
But you can't
'Cause you are too weak.
I am strong 'cause I drink Gatorade
I explode like a hand grenade.

Figure 8. D Swift's Rap

Dyson writes that we can begin to help children learn grow as writers by recognizing "the tools of early writing: the pencil...and the voice" (Dyson, 1981, p.784). When a child uses the Memory Stack as her composing tool, she uses a keyboard rather than a pencil, and integrates not only the voice, but the tone and narrative structure of her oral language into the writing process in a new kind of composing activity made possible by new technology.

Note: For a more complete description of the functioning of *HyperCard* 2.0, the Audio Palette and the Memory Stack, see Gannon, M. (1992). "Talking texts: The new Macintosh computer and the reading/writing classroom."

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Project (W2-203A)

Using Technology to Make Connections in Geometry

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Key words: geometry, technology, secondary mathematics

Abstract

The Connected Geometry project at EDC is a curriculum development project funded by National Science Foundation to develop innovative and flexible materials for secondary mathematics. Our goal is to make mathematics compelling and attractive to students. We hope to do this by bringing a culture of mathematical exploration into the classroom, by connecting students' experiences of various parts of mathematics with each other, and by connecting mathematics to the rest of students' experiences. We believe that to help teachers and students engage in meaningful mathematical activity, curriculum materials must offer an understanding and appreciation of the connections and unifying themes within mathematics, and between mathematics and human experience.

Technology plays a central role in Connected Geometry materials in enabling students to experiment with, analyze, and explain mathematics. In particular, we are developing activities and curriculum materials that use computers and technology:

- to enable students to investigate and experiment with important themes in twentieth-century mathematics.
- to enable students to use technology as a tool for explaining, questioning, modifying, and even proving conjectures that arise in experiments.
- to aid teachers iteachn implementing curricular and pedagogical changes in their classrooms and schools.

Examples to be used in the presentation will draw upon activities from our project materials and may include explorations of activities such as the following:

- the construction of a perspective drawing of a checkerboard using dynamic geometry software environments like the Geometer's Sketchpad (Key Curriculum Press), Cabri Geometre (Brooks-Cole), The Geometry Inventor (WINGS for learning), and the Geometric SuperSupposer (Sunburst).
- the investigation of an optimization problem in which students determine the "best" place to locate an airport that will service three cities.

Throughout the presentation, we will ask participants to consider how the use of technology, and in particular, flexible environments for visualizing mathematics, suggest new ways to think about the mathematics we .

Project (W2-203B)

A Computer Environment for Elementary Geometry and Spatial Sense1

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Key words: Logo, mathematics, geometry, spatial, turtle, programming

Abstract

Logo was developed to serve as a conceptual framework for the learning of mathematics. Therefore, one rationale for Logo programming is that students will learn geometry by utilizing concepts that aid them in understanding and directing the Logo turtle's movements. Research on this claim has yielded mixed results; however, an analysis of these findings provides significant guidance in the teaching and learning of geometry with Logo. We are engaged in a large-scale curriculum development project, funded by the National Science Foundation (NSF), that emphasizes meaningful mathematical problems and depth rather than exposure. Our responsibility is developing the geometry and spatial sense strands. Students will engage in investigations involving a wide range of approaches and materials; we designed a modified Logo environment specifically for the project. We based the design on curricular considerations and a number of research implications for the learning and teaching of geometric concepts with turtle graphics. In the presentation, we (a) briefly review the body of research that led to the design of the environment, and (b) describe and demonstrate the software environment, Geo-Logo and its connections to this research. Our research review yielded 5 principles for Geo-Logo's design.

1. Encourage construction of the abstract from the visual. The environment should allow students to build on their visual strengths, but concomitantly increasingly demand complete and precise specifications; formal, symbolic representations; and analytic thinking. Computer tools need to constrain students' actions. They must serve as a transition device, connecting the intuitive and the visual to the symbolic and abstract.
2. Maintain close ties between representations—Logo code, the action of the turtle, and the resultant figure. Establishing bidirectionality between the visual and symbolic modes may strengthen of these connections.
3. Facilitate examination and modification of code—ease of editing and repeating constructions and operations, along with "undoing," "stepping" and similar functions. The rationale for such functions goes beyond simple convenience; the tools should embody the critical Piagetian concept of reversibility.
4. Encourage procedural thinking. The environment should support easy creation, alteration, and use of procedures.
5. Provide freedom within constraints. The environment should allow students and teachers to pose and solve their own problems, encouraging exploration and conjecture. At the same time, teachers should be encouraged to present, and students to engage in, certain structured tasks.

We will demonstrate Geo-Logo, revealing how its features embody these principles. Features include measurement tools, dynamic dual-direction connections between symbols (Logo code) and graphics, aids for defining, changing, and stepping, through procedures, and tools for geometric transformations such as rigid motions and scaling. We will show how Geo-Logo is embedded in the curriculum units, and give brief examples of classroom results.

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Project (W2-204A)

Computers in Science: A School-based Training Program for Applying Technology to Elementary Science Curriculum

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Key words: technology integration, elementary science, staff development, Concerns Based Adoption Model

Abstract

The purpose of the Computers in Science project was to train the faculty and staff of an elementary school to use technology in implementing the Baltimore City Public Schools (BCPS) hands-on science curriculum, STARS (Science, Thinking, Application, and Research Skills) across the disciplines with all students. The training outcomes were: (a) the teachers' expanded knowledge of elementary life, chemistry, physics, and earth science concepts; (b) implementation of model lessons that integrated technology with the STARS science units by using elementary level tool software (i.e. word processing, graphics, desktop publishing, database, and spreadsheets), commercial interfacing devices, on-line electronic databases, and CD-ROM resource materials; (c) inclusion of students with special needs in the full range of science activities; (d) development of performance-based assessments for monitoring student progress; and (e) teachers adequately prepared to support and coach other BCPS teachers.

Program description

The Computers in Science training program was designed to meet four needs: 1) development of model science and technology curriculum programs; 2) use of technology to include students with special needs in the science-technology curriculum; 3) improvement of student progress monitoring and instructional decision-making; and 4) provision of an appropriate teacher training model for science and technology instruction and for student assessment and accountability. The training was held at a BCPS elementary school using the resident computer equipment (a distributed network of 45 IBM work stations, four placed in each instructional area), software, and commercial interfacing devices applicable to the STARS curriculum materials. Training sessions were lead by the project coordinator assisted by education instructional specialists from IBM. Frequent site visits between sessions were made to support the implementation of the training. The entire staff, general and special education teachers, participated in the year-long training program.

This Computers in Science program strengthened the faculty's knowledge of science and technology, enhanced students' skills, knowledge and motivation for learning in science and across the curriculum, increased parent and community involvement in the school, and encouraged students to use technology for achieving academic excellence.

Evaluation

The evaluation of the effectiveness of the project was based on the following outcomes:

(a) improved student learning through the use of a science-technology focused curriculum; (b) increased involvement of the school and community in teaching science; (c) development of model lessons for using technology as an instructional tool in implementing the science units and for integrating science across the disciplines; (d) the inclusion of students enrolled in special education in the full range of the science-focused curriculum through appropriately adapted instruction using technology; and (e) a staff prepared to support the training in the use of technology in science for other BCPS elementary teachers.

Data were collected to determine the effectiveness of the training program using the diagnostic dimensions of the Concerns Based Adoption Model (Hord & Hall, 1978) which include questionnaires, interviews and observations. Other information was gathered from standardized test data, logs, and informal evaluation procedures.

Results

The training model included the delivery of information about the use of computers for instruction and hands-on practice. Participants actively collaborated to accomplish the planning for integrating science across the curriculum. This collaboration fostered collegiality and support among the participants in their efforts to master the requisite skills for using technology in the classroom.

Once the computers were installed, progress escalated in competency with computers and integration into instruction. The assessment procedures confirmed that as the staff gained experience with the computers in science and integration across the curriculum, their personal concerns dissipated and their level of use progressed toward routine implementation.

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Project (W2-204B)

Using Technology to Link Current Science Research to Restructured Classrooms

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Key words: fractals, guided discovery, randomness, models, networks

Abstract

We discuss the classroom impact of adapting the method, structure, and spirit of modern science research experiments and computer models to the high school classroom. The subject matter introduces students to the role of microscopic randomness in creating macroscopic patterns—many of which are fractal—in the sciences. Natural phenomena such as the growth of snowflakes via random aggregation demonstrate that such random microscopic processes give rise to predictable macroscopic behaviors.

The materials are based on incorporating hands-on activities, laboratory experiments, and computer modeling and data-analysis tools. Observations show that using these materials leads the student naturally to the role of investigator and the teacher to the role of mentor, a type of "cognitive apprenticeship" instructional approach that shares essential features with graduate level science education. The projects described in our materials encourages students to work cooperatively and to actively investigate natural patterns such as nerve cells, lightning, river deltas, galaxy formation, the fine structure of tree branches, and the raggedness of the Norwegian coastline.

The applicability of these educational materials to students from a wide range of backgrounds appears to result from the generality of the rules embedded in the physical models, the availability of computers to apply these to large systems, and the ease with which students successfully manipulate the resulting interactive visual displays.

Our project has examined how these changes in classroom structure affect student learning. We have studied the depth of student understanding and investigated the specific conceptual changes and barriers to learning that students experience with abstract topics such as probability which is a key mathematical concept in understanding randomness. These research findings help to define a set of possible conditions for moving students towards cooperative and investigative learning.

Finally, we speculate on the potential for other scientists from other disciplines to adapt their current research to high school classrooms and on the promise of electronic networks in giving all students access to this and similar initiatives nationwide.

Revolutionary Classroom (W2-207A)

How the Transparency of a Distributive Network Revolutionized Teaching and Learning

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Key words: classroom computers, restructured instructional time, staff development, brain-based, student-centered, teacher facilitator

Abstract

At NECC '92, Northbrook Middle School was introduced to the conference attendance through the presentation "The Transparency of Technology at a Distributively Networked School. This presentation, How the Transparency of a Distributive Network Revolutionized Teaching and Learning" will present the revolution which as occurred during the past two years!

The Power of the Three T's: Technology, Teachers and Time in Restructuring Schools

Networked classroom computers, restructured instructional time, and staff development afforded to all teachers, a traditional teacher-centered environment devoted to whole class activities has been replaced by a brain-based, student-centered classroom with the teacher facilitating, encouraging, and motivating. This presentation will illustrate the different teaching strategies and assessment methods including the regular incorporation of technology into every curricular area. Documentation of increased student achievement will be shared.

In August, 1991, Northbrook Middle School (Spring Branch ISD, Houston, TX) opened its doors to sixth, seventh, eighth grade students as a technology demonstration middle school equipped with 400 Macintosh and 25 MS-DOS computers distributively networked each to the other. Teachers who were chosen to teach at this school did not necessarily possess technological attributes or knowledge of current teaching strategies. During the past two years a revolution has been in the process—a revolution regarding the way children learn and the way teachers teach!

Since technology is everywhere, it is transparent, matter-of-fact and students

- participate in the writing process using computers,
- use technology in problem solving in mathematics,
- access data when doing research through databases locally and online from remote resources,
- be able to dialog with others outside of the school parameters in our global community
- search card catalogs electronically for resources in the building, in the district, in the world
- make visual presentations using multimedia as well as the traditional written presentation
- integrate Internet communication into all curricular areas.

Northbrook is dedicated to the true middle school concept with students being housed in an area serviced by a common core of teachers. The day is divided into a eight-period modified block schedule of four 90 minute periods meeting alternate days. This block scheduling blends with the integration of technology into the curriculum by giving the students more time. Teachers have a conference period as well as a team planning period. The team planning period enables the team of teachers to plan inter-disciplinary units integrating and embedding technology into the teaching and learning process.

Revolutionary Classroom (W2-207B)

Constructing Learning As You Go: KCOT in Action

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Key words: constructivist, Macintosh, community, projects, integrated curriculum

Abstract

Take fifty-five seventh graders, two master teachers, two university interns, one large classroom with a folding wall, a generous sprinkling of technology (including a half dozen Macintosh computers, Apple IIe's, camcorders, and an AlphaSmart or two), and spread them over four hours of the school day, integrating all the traditional core subjects. This is the Kellogg Classroom of Tomorrow (KCOT) Program at Kellogg Middle School in the Shoreline School District north of Seattle, Washington.

KCOT students routinely use computers, multimedia tools, and productivity software. Technology allows access to information on the Internet, desktop production of a community newsletter, and design of a multitude of individual projects. Whole group efforts have included intensive study of a wetland site under the auspices of the TERC Global Lab Project, and the publishing of SEATTLEITE, a magazine for young people moving into the area. Individual and small group efforts have included videos on endangered species, participation in the Internet MathMagic project, and numerous *HyperCard* stacks.

The presentation features work done by students, a discussion of the role technology plays in a constructivist classroom, and a description of how the KCOT community has developed. Together we are preparing for the future. It's been an exciting year!

Special Session (W2-208A)

CamMotion™: Using Digitized Video as Data in Mathematics

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Key words: mathematics, video, data, middle school, modeling

Abstract

In the VIEW (Video for Exploring the World) project at TERC, we are, developing software called CamMotion TM to support the use of video as a laboratory instrument. Video provides students with an expanded world of phenomena to analyze because it can stop time and make events repeatable. By making measurements on single frames of video they have made themselves, students can explore the "fine structure" of events that take place quickly, such as balls bouncing, or paper airplanes being thrown. They can also examine patterns of motion that show up in jump rope, juggling, or gymnastics.

CamMotion™ provides a palette of on-screen tools for measuring position, distance, angle, and area, among others. A graphical overlay window provides a growing record of the data being collected against a background of a single video frame. To account for pan and zoom in the video, tools are available to change the scale of the data coordinates and to specify an

anchor point whose position on the screen changes over time. Individual datasets can be combined in a worksheet within which a set of transformations (e.g. taking the differences between consecutive measurements) can be applied. A graph window provides a flexible environment in which several different curves can be compared. The user can select a section of either the graph or the worksheet and see the piece of the video that corresponds to that slice of the data. We will demonstrate the software and show examples of the kinds of mathematical activities that students can carry out with it.

Special Session (W2-302A)

KIDLINK creates a Global Community of Youth: A Special Panel with Key KIDLINK Leaders

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Key words: KIDLINK, telecommunications, international, electronic mail, secondary, elementary

Abstract

The KIDLINK Project is one of the major successes of the educational use of telecommunications. In 1990, Odd de Presno in Saltrod, Norway had the idea of creating a global dialog of youth through the medium of electronic mail. The idea caught on immediately and participation has grown steadily over the years. Odd is now assisted by an international group of volunteers who are part of the KIDLINK Society. Thousands of kids from nearly 60 countries have made friends and forged deeper understanding of each other on KIDCAFE, the mailing list for students. But this is only a small part of KIDLINK. There are now several KIDLINK telecommunications activities, all for students between the ages of 10 and 15.

- KIDFORUM provides an outlet for written works by kids on a series of topics specified in advance. It is designed to promote exchanges between classroom groups of students (although individuals are welcome) with each topic lasting for 6-8 weeks. Recent topics have included Virtual Vacation, War and Peace, and Sports (during the winter Olympics).
- KIDPROJ allows classrooms to form partnerships to develop and implement collaborative learning activities through telecommunications. Current projects include the compilation of a Multicultural Calendar of Holidays and the following of the British Arctic Drift Expedition.
- KIDLINK IRC (Internet Relay Chat) provides a protected and safe environment for real-time dialog among groups of kids and teachers. One of the most exciting moments this year was being online during the STS-51 shuttle launch with a science teacher on the causeway at the Kennedy Space Center.
- KIDCLUB is a newly formed group of youth clubs which meets every Saturday on KIDLINK IRC to discuss ways they can help their communities by using communications technology. KIDPROJ is working to pair each American youth group with a group outside the US.

The members of the panel are the people who created and run these activities. They will give brief progress reports and discuss their plans for the future. They will also discuss KIDLINK efforts to reach out to those areas of the world that are not currently well connected via telecommunications.

Project (W2-308A)

Elementary School Students as College Faculty

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Key words: computers, elementary, university, partnerships

Abstract

A collaborative project between the College of Education at Butler University and William McKinley Elementary (IPS 39) has been initiated and is ongoing. In this project selected students from grades two through five to act as "visiting faculty" at Butler University to teach specific topics in an introductory computers in education course. In the past three semesters, approximately two dozen students have acted as visiting faculty. They have been organized in small groups from two to five children. These small groups of elementary students have coached college students through various activities including the completion of drawing projects, *HyperCard* projects and desk top publishing projects.

Anticipated Outcome

Most undergraduate students in Butler's teacher preparation program are required to take a course on computers in education. Many of these students complete this class with major misconceptions about what young children can do with technology. These misconceptions are evidenced by comments such as "this stuff is great, but little kids can't do it. It's too complicated." This project was initiated to correct these misconceptions. It was hoped that the college students involved in this project would not only gain knowledge of the capabilities of young children with technology, but also gain an appreciation for their abilities.

The power of the project was evident in the college student's reaction to the children in their class. They expressed significant surprise, bordering on awe at the ability of the children. The students from IPS 39 not only demonstrated their skill with the hardware and software, but also demonstrated a conceptual knowledge sufficient to teach others. The college students made unsolicited comments like "it was just like having a regular professor teach the class."

Unanticipated Outcomes

Although it was expected that the elementary students could handle the task of teaching college students, the level of professionalism shown was surprising. IPS 39 is an inner-city school. Most of the typical "advantages" that it's students have come from their school experiences. Their school culture at least partially reflects their home cultures. However, when these children were "picked up and dropped" on the suburban Butler campus, they were indistinguishable from their suburban or rural counterparts.

It was hoped that this project would positively impact the children's self esteem and self confidence. The level of the effect in this arena was remarkable. The children were visibly changed during the experience. Although they were initially somewhat shy about interacting with college students, once they got started helping them, they quickly overcame that initial shyness. Their confidence in their skill and knowledge was very solid, and this activity gave them the opportunity to externally validate their abilities. They were treated like experts, and from observing them, we believe they felt lie experts. Reports from teachers at their school indicated that the effect lasted for more than the single day that they served as visiting faculty. Several of the children were featured in the news papers as well as on local and national news broadcasts. These children were awarded celebrity status by their school mates for some time afterward.

This project will be continued with minor modifications, becoming a standard element of the Instructional Technology curriculum at Butler, and a regular opportunity for IPS 39 students.

Project (W2-308B)

Schools of Education and Technology Preparation: Are We Doing Our Job?

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Key words: pre-service education, curriculum integration

Abstract

This study surveyed teachers following their first year in the classroom. They were asked about their experiences during their pre-service program and their perceptions of computer experiences during their pre-service program and if they felt they had been prepared to use computers in their teaching. Findings indicate that only a small percentage of these teachers feel they were prepared. Factors that relate to the sense of preparedness are identified. The results of this study have implications for the restructuring of teacher education programs. The findings are examined in light of the recent ISTE Foundation Standards recommended for all pre-service teachers.

Background

The need to prepare pre-service teachers to integrate technology into the range of instructional strategies they bring to their teaching is not a new concern and has been addressed in the literature in a variety of studies and articles. These authors have urged that pre-service teachers need experiences to make them comfortable with the use of computers and to gain the ability to integrate them into the curriculum as an instructional tool. Although 89% of teacher education programs offer an opportunity for computer training of their pre-service students, only 29% of the respondents to a national survey of education majors saw themselves as prepared to teach with computers (U.S. Congress OTA, 1988). Recent studies found the use of computers in elementary education programs inadequate for training teachers for the 21st century (Handler, 1993; Ingram, 1992).

Integrating technology into schools of education has not found to be an easy task. Ways in which technology can be infused in teacher has been described by Handler (1993), Jongejan (1990),and Novak and Berger (1990) Ideally, it would be best to incorporate the technology across the college curriculum with professors modeling its use (Munday, Windham & Stampfer, 1991). That is not an easy task and requires a strong commitment on the part of the institution. Equally important is the identification of what elements of a program made a difference to these new teachers as they first experienced working in their own classrooms. Novak and Berger (1990) provided information on areas in which teachers had a sense of deficiency. A survey of teachers from one institution, after their first year of teaching, identified the elements that had made a difference for those that had felt prepared (Handler, 1993). Handler found that the modeling of the uses of technology during the student teaching experience and the use of technology within the methods block were key factors in the perception of those surveyed.

The Study

Institutions with teacher education programs near a major metropolitan area in the Midwest agreed to participate in a survey of their 1991 teacher education graduates. Four institutions agreed to provide the authors with mailing labels for recent teacher graduates while the fifth requested surveys be sent to them for mailing. The sixth institution was the researchers' own university. 998 surveys were initially mailed, followed by a second mailing to all those who did not respond. 61 surveys were returned with no known forwarding address. Of the total 937 surveys sent, 226 were returned for a 24% response rate.

The question of what elements they perceived as important in their sense of feeling prepared has been examined. While not all schools had a required introductory course each institution appeared to offer at least one course. More of the teachers who felt prepared had enrolled in this introductory experience. Only a small number of respondents were placed in classrooms where technology use could be observed or used during either their preclinical or student teaching experiences. The findings also indicate that those students who saw the use of technology modeled either by the faculty of the school of education or by cooperating teachers were more likely to feel prepared to use computers and other technology in their own classrooms. Those who felt prepared were also more likely to indicate that they incorporated the computer into their teaching. Feeling prepared was not linked to being a personal user since both groups indicated that attribute. The most influential experiences appear to be occur during pre-service preparation. The question of why so many of these students felt unprepared carries a strong message to schools of education as they restructure their programs in response to the ISTE foundation standards.

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Special Session (W2-310A)

Standards for Technology in Learning and Teaching

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Key words: accreditation, standards, curriculum, NCATE, ISTE

Abstract

The International Society for Technology in Education (ISTE) Accreditation and Professional Standards Committee has developed standards for teacher preparation that address specialization in computer literacy, in secondary computer science, and in educational computing and technology leadership. These standards have been adopted by the National Council for Accreditation of Teacher Education (NCATE) and are currently being used to evaluate programs in the United States.

In addition to these specialty area guidelines, ISTE recognizes standards for preparation of all teachers regardless of their individual subject area specialty. These are called the ISTE Foundations Standards and are identified in the NCATE guidelines as prerequisite to specialty preparation and by ISTE as essential for every teacher.

The NCATE is currently in the process of revising standards for the accreditation of professional education units. The unit guidelines set criteria for evaluating aspects of the total teacher preparation program such as curriculum, quality of instruction, faculty qualifications, resources for teaching, scholarship, communications and professional productivity. The ISTE suggested changes to these guidelines are designed to strengthen the support for the use of technology in teacher preparation programs. The draft of the new unit guidelines included the ISTE suggestions. If adopted in the final guidelines, the new standards will help to ensure technology access, expertise, and use within colleges of education and will facilitate modeling of appropriate use of technology by teacher educators.

The Accreditation and Professional Standards Committee is poised to embark on two new projects: revision of the ISTE Code of Ethics and development of standards for use of technology in elementary and secondary education. The standards documents to be developed include:

- ***Technology Curriculum Standards*** describing what students should know about technology and be able to do with technology;
- ***Educational Technology Support Standards*** describing appropriate access, staff development, and support services schools should provide to facilitate the use of technology;
- ***Standards for Using Technology in Learning and Teaching*** describing how technology should be used to achieve the National Education Goals ; and
- ***Standards for Student Assessment and Evaluation of Technology Use*** describing means of assessing student progress and evaluating the use of technology in learning and teaching.

This panel will address issues relating to the accreditation process, its impact, and opportunities for leadership in future development and evaluation projects. The development of standards for elementary and secondary education will be outlined and opportunities will be provided for the audience to give input, to identify resources and expertise, and to determine future directions for this development activity.

Society Session (W2-311A)

Design of an Information Literacy Course for Learning at a Distance (ACM SIGUCCS)

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Key words: information technology, library studies, electronic networks, higher education, distance learning

Abstract

Information technology has created the need for the users of such technology to acquire the tools and skills to access information from their office, from their home, from the library, and many other places. At the Pennsylvania State University such a need is being addressed through the design of a course as part of a Library Studies program. This course addresses the organization and retrieval of information. The focus is on what is information, communicating of information, an introduction to electronic mail, using electronic networks to access information, evaluating the worth of information, creation of information, how much does information cost, using information to make decisions, and responsibilies of elctronic consumers. This course is being implemented as part of the University's Independent Learning program so that students can take the course without have to do so in a traditional classroom.

Paper (W3-201A)

Breadth-Oriented Outcomes Assessment in Computer Science

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Key words: computer science, computing literacy, outcomes assessment

Abstract

Given the immaturity of computer science as a discipline, curriculum planning and organization remains a subject of much debate. Moreover, little work has been done regarding the overall assessment of quality of computer science graduates at the baccalaureate level. In this paper, we report on an initial prototype of an assessment instrument designed to evaluate the breadth of knowledge of computer science seniors. The instrument seeks to evaluate two areas: technical knowledge and knowledge of computing history and culture. Our results indicate that our curriculum does appear to contribute to students' technical knowledge; however, students are emerging with very little knowledge of the history and culture of computing. As a result of this apparent lack of knowledge, we are currently adding a new capstone course to our curriculum. This paper discusses the design and rationale for this course.

Introduction

To date, little work exists regarding the overall assessment of the quality of undergraduate computer science students. Such quality assessment (often called *outcomes assessment*) is becoming a topic of increasing interest in other disciplines (Light, 1992).

A number of techniques exist for performing outcomes assessment of computer science majors. Given that much of computer science is oriented toward design and problem solving, an examination devoted to such activities is intuitively appealing. However, one can excel at design and problem solving activities and yet fail to have a basic knowledge regarding many fundamental computer science concepts. We believe that a successful computer science program should not only instill design and problem solving skills, but should also provide the student with the knowledge of basic, fundamental concepts from across the breadth of the discipline. Moreover, the student should possess the ability to recall, understand and utilize such concepts. At the very least, a successful student should be able to converse on any of these concepts, even if the student has not "mentally referenced" the concept for a long period of time. In this paper, we refer to the basic knowledge of a wide variety of fundamental concepts about a discipline as ***breadth-oriented*** knowledge.

Based on these concerns, we have developed a prototype computer science outcomes assessment that tests for breadth-oriented knowledge in computer science. In a recent pilot study, we administered this assessment to several distinct groups of computer science students at The University of Alabama. This paper reports on the results of this pilot study. In this study, we attempted to address three general areas:

1. Are our students graduating with breadth-oriented knowledge that spans the computer science discipline? Do our students have an appropriate foundation of computer science concepts (in addition to whatever problem solving skills they might have)?
2. Our computer science curriculum is designed to be ***breadth-first***, in the sense that it contains a breadth-oriented introductory course (Cordes, 1992; Denning *et. al.*, 1989). Breadth-first curriculum design in computer science has been a subject of considerable discussion and controversy (Baldwin, 1990; Locklair, 1991; Motil, 1991; Pratt, 1990). What is the value of such a course in building a breadth of knowledge about the discipline? How do students who have just finished a course covering the breadth of the discipline compare (in terms of breadth knowledge) to advanced students who have primarily been taking specialized courses for the past two years?
3. Are our students graduating with an appreciation of the history and culture of computing? As an example, are students able to recognize the contributions of major figures in the computing field?

While (3) may be secondary in importance to technical knowledge, we consider it ironic that students that are not computer science majors may actually have a better exposure to these issues than our majors. Issues related to (3) are often covered in computer literacy courses for non-majors. However, such issues often receive little coverage in majors courses where there is often too little time to properly cover technical topics.

In the remainder of this paper, we report on the results of our pilot study. In Section 2, we address the general design of our study, as well as the design of our assessment instrument. In Section 3, we address the above three sets of questions. Section 4 summarizes our conclusions and recommends several areas for future research.

Design of the Study

The pilot study took place during the Spring 1993 semester at the University of Alabama. The students involved in this study ranged from second-semester freshman to graduating seniors. The test was given during a regular class meeting. None of the students involved in the study knew of the exam prior to that day, and thus had no preparation time. Specifics of the organization and administration of the exam are provided in the following sections.

Exam Organization and Structure

The basic exam consisted of 100 questions. These questions covered the basic areas of the discipline (algorithms, architecture, data structures, operating systems, programming languages, software engineering, history and cultural issues, and basic computer literacy). The questions were divided into four basic categories, as shown below:

- Basic definitions using multiple choice answers (25 questions)
- Deeper questions, ones that required some analysis beyond simply knowing the basic definitions, also incorporating multiple choice answers (25 questions)

- A second set of 'deep' questions, similar to the previous section only having True or False answers (20 questions)
- More definitions, heavy on the history and culture of the discipline, using matching answers (30 questions)

The questions in these four sections attempted to provide a broad, uniform covering of the discipline of computing. The first section of the exam consisted of basic definitions and terms that students within the discipline should know. The majority of questions in this section were *'literacy-based,'* that is, the questions in it were general literacy questions. Sample questions included items such as:

1. *ASCII*
    - a. American System for Coding Idioms and Icons
    - b. Applied Structured Coding with Intelligent Interfaces
    - c. American Standard Code for Information Interchange
    - d. Automated System Certification version II
2. *Semiconductor*
    - a. a compound with a limited ability to conduct an electrical charge
    - b. pure silicon, a tightly crystalline structure
    - c. the term used to refer collectively to a collector, base and emitter
    - d. a group of transistors connected by aluminum strips

The next two sections consisted of 'deeper' questions that required some actual thought on the part of the student in order to solve the problem. These questions were both multiple choice and true/false questions. Sample questions of each category are shown below:

1. *A depth-first search operates as follows:*
    - a. start at a node, visit its neighbors, then visit its neighbor's neighbors, *etc.*,
    - b. start at a node, visit one neighbor, then visit one of the neighbor's neighbors, *etc.*, stopping when you reach the depth of the graph
    - c. search a graph from one end to the other (graph depth) as quickly as possible
    - d. start at a node, visit one neighbor, then visit one of the neighbor's neighbors, *etc.*, backtracking and trying other unvisited neighbors until all nodes are visited
2. *The maximum number of items stored in a binary tree of height 4 is:*
    (a) 15 (b) 16 (c) 31 (d) 32

T/F A stack is simply a list where insertion and deletion are ensured to take place in FIFO (first-in-first-out) order.

T/F Most compilers for high-level languages can detect infinite loops at compile time.

T/F For an ordered tree, the results of printing the tree in prefix and postfix order are identical.

The final section of questions consisted of additional basic definitions and terms, similar to the first section but using matching. This section also placed a heavy emphasis on the historical and cultural issues of our discipline. A subset of questions from the matching section is shown below:

1. big-endian
2. bandwidth
3. karnaugh map

A. designs sums-of-products from truth tables
B. promoted structured programming constructs
C. the range of frequencies on a carrier signal

4. LL parsers	D. developed language SMALLTALK
5. VonNeumann	E. orders bytes from left-to-right
6. Dijkstra	F. top-down, recursive descent or table driven
7. Kay	G. developed language LISP
8. McCarthy	H. developed framework for modern-day computers

The exam, as it was originally designed, was intended to assess the knowledge of our students (at various stages within their careers) regarding the technical information within the discipline. Thus, the majority of the examination emphasized the technical issues associated with computing. However, a significant number (approximately 15% of the exam) focused on the history and cultural issues associated with computer science. As this study was an initial pilot project, it is anticipated that the exam administered next Spring will focus more strongly on these cultural and historical issues.

Exam Administration

As mentioned previously, the exam was presented to the students (unannounced) during a regularly scheduled class meeting towards the end of the Spring semester. The exam was administered to three different classes, including a second-semester freshman-level course, a sophomore/junior-level course, and a course consisting primarily of graduating seniors. The three courses involved were:

- CS 124: Introduction to Computer Science: This course is a second-semester freshman course. It assumes as its pre-requisite CS 114 (Introduction to Computer Programming). Thus, all of the students within the course are familiar with the concepts of programming and software development. It then develops a breadth-first introduction to the discipline of computing as a whole. As the students are familiar with programming issues, it is possible for them to implement prototypes and examples of the various issues the students are exploring (operating systems, compilers, complexity, *etc.*). Course content includes algorithms, data structures, basic architecture, fundamentals of complexity and computability, and the foundations of operating systems and programming languages.
- CS 325: Software Development and Systems: This course is part of the 'middle tier' of the major at the University of Alabama. After students complete the first year of the discipline, they must complete four additional CS courses (data structures, assembler, discrete math, and this course) prior to moving on to the upper-level courses in the discipline. Most of the students in this course have been in the major for approximately one and a half years, and are ready to start taking senior-level courses the following semester. This course is designed as a scaling course (Cordes & Parrish, 1993a; Cordes & Parrish, 1993b), migrating the student from a small-scale, single-person development environment to a larger-scale software development environment.
- CS 426: Introduction to Operating Systems: This is one of four required senior-level courses within the major. All students must take this course prior to graduation, and the majority of the students in this course were in their last semester at the University of Alabama when this exam was administered.

Each instructor involved in the study announced the test at the start of the period. After this, the remaining students were given the exam and allowed 75 minutes in which to complete the exam. The exams were then accumulated and graded. An analysis of the results (and their implications) is presented in the following section.

Analysis of Results

In this section, we examine the results of our pilot study by looking at the three questions outlined in the introduction:

1. Do our graduating seniors (*i.e.*, CS 426 students) possess adequate technical knowledge spanning the breadth of the discipline?
2. Does the introductory breadth course (CS 124) contribute to breadth knowledge?
3. Do our students have adequate exposure to historical and cultural issues in computing?

These questions are addressed separately in the subsections below.

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Issue (1): Breadth of Technical Knowledge

To address this question, we wish to consider the performance of our seniors on technical questions. The results for all three groups (based on the 88 technical questions) are given in Table 1 below.

Group	Mean	Std. Dev.	N
CS 124	40.8780 (45%)	9.3011	41
CS 325	50.2683 (57%)	10.2250	41
CS 426	60.0345 (68%)	8.4282	29

Table 1

Of course, the question of whether 68% is "good enough" is a subjective one. However, the mean GPA for the seniors taking the exam is 2.88, indicating an overall C average for the group. Based on the typical procedure used here for exam evaluation, a 68 is a borderline C. So the technical score is roughly consistent with the quality of students taking the exam.

As an additional metric, we examined the total number of questions "mastered" by the three groups. We say that a question is ***'mastered at level N'*** if at least *N*% of the students answered the question correctly. Table 2 below indicates the number of technical questions mastered at the 66% (two-thirds) and 80% (four-fifths) levels by the three groups:

Group	66%	80%
CS 124	22	10
CS 325	32	19
CS 426	55	38

Table 2

Thus, at least two-thirds of the senior students mastered 55 questions (62% of total). While this number is not as high as we would like, it does seem to represent mastery of a substantial percentage of the material, and provides a baseline against which to compare in future studies.

Issue (2): Value of the Introductory Breadth Course

As discussed earlier, the inclusion of breadth-oriented introductory courses in computer science curricula has been the source of some controversy. Much of the controversy has been centered on the contribution of the course in terms of providing a foundation with respect to the overall discipline. The idea of having a breadth-oriented introductory course was formalized in the well-known Curriculum '89 report (Denning, *et. al.*, 1989). However, others have suggested that computer science curricula should adhere to a model where the foundation of the program should be based on depth-oriented courses in design and problem solving, rather than exposure to material covering the entire breadth of the discipline (Baldwin, 1990; Motil, 1991; Pratt, 1990).

One way to assess the contribution of breadth-oriented courses in providing a foundation for the remainder of the curriculum, is to separately consider two questions:

1. Does a breadth-oriented introductory course really contribute to breadth knowledge?
2. Does breadth knowledge provide a foundation for the remainder of the curriculum?

By administering a breadth-oriented exam to students completing CS 124, this study begins to address question (1). In particular, consider Table 2 in Section 3.1 above. Two observations (one negative, one positive) are evident from this table:

- Students completing CS 124 have only mastered (at the two-thirds level) about 25 of the material covered on this exam. Thus, three-fourths of the questions were inaccessible to most of these students. Consequently, there is a definite limitation to the degree of breadth students are able to obtain from a one-semester course.

- Students completing CS 124 mastered approximately 40 of the material mastered by the graduating seniors. This is significant when considering that these students have only completed 8 hours in the computer science curriculum (versus 45 hours for the seniors).

Thus, while students taking an introductory course have not mastered general questions spanning the entire breadth of the discipline, they have mastered a substantial percentage of what they likely will ultimately acquire.

Thus, while our introductory breadth course does not result in complete command of the breadth of the discipline, it clearly contributes substantially to the breadth of knowledge that students ultimately obtain. Further research is needed to determine whether an initial breadth course provides a good foundation for the rest of the curriculum.

Issue (3): History and Cultural Knowledge

As observed earlier, there were 12 questions on the exam devoted to primarily "historical and cultural" issues. All but one of these questions required the identification of major contributors to computing and related disciplines. One additional question required students to identify the meaning of the acronym "ACM" (*i.e.*, Association for Computing Machinery). The list of major figures that students were required to identify is as follows:

Dijkstra
Chomsky
Knuth
Babbage
McCarthy
Backus
Roussel
Kay
DeMorgan
VonNeumann
Hoare

All of the questions related to this area are found in the matching section of the exam in the Appendix (Questions 71-100).

As Tables 4 and 5 illustrate, student performance on this area of the exam was universally poor. Table 4 shows student mean subscores on these 12 questions, while Table 5 shows the percentage of students from each class getting each question correct.

Group	Mean	Std. Dev.	N
CS 124	2.0488 (17%)	1.8021	41
CS 325	2.6098 (22%)	1.3206	41
CS 426	3.8966 (32%)	1.9151	29

Table 4

Question	CS 124%	CS 325%	CS 426%
Dijkstra	4.9	14.6	17.2
Roussel	14.6	2.4	27.6
Chomsky	2.4	7.3	20.7
Kay	7.3	0.0	3.4
Knuth	12.2	17.1	27.6
DeMorgan	7.3	26.8	34.5
Babbage	39.0	48.8	65.5

VonNeumann	17.1	34.1	44.8
McCarthy	17.1	2.4	17.2
Hoare	9.8	0.0	17.2
Backus	12.2	12.2	13.8
ACM	61.0	95.0	100.0

Table 5

Although this is a small sample of questions, most students were unable to identify *any* of the major contributors to the computing field. This is particularly problematic, given that computer literacy courses for *non-majors* routinely cover many of these contributors to the computing discipline. We suspect that although many of these individuals are mentioned from time to time, students are never placed in a position of having to assimilate and organize information about all of them for long-term recall. Consequently, our response to these results has been to develop a new capstone course whose primary purpose is to present a retrospective over a variety of non-technical issues in computing. This required course, entitled "Ethical and Societal Issues in Computing," covers a variety of legal, ethical, historical and cultural issues. Its outline appears as follows.

CS 440: Ethical and Societal Issues in Computing	
Week	**Topics**
1-2	History and Culture of Computing Defining the discipline of computer science Major contributors to computing ACM, IEEE, Turing Award
3-4	Ethics in Computing Principles of Ethical Behavior/Case Studies ACM Code of Professional Conduct
5-6	Computer Crime Computer hackers, viruses and worms Case studies of criminal activity
7-8	Computing Risks Causes of computing failures/case studies Safety-control techniques (software/hardware)
9-11	Legal Issues Product liability Software patents and copyrights Intellectual Property Rights
12-15	Student Paper Presentations and Debates

This three (semester) hour course will be offered for the first time during the academic year 1994-95. Our objective in offering this course is to ensure that students have a background in social and cultural issues that is (at the very least) comparable to the backgrounds of students emerging from non-major computer literacy courses. We also wanted to provide a course that gives students an appropriate background in ethical and legal issues, given the current interest in this subject (Weiss, 1990). This course has the potential to combine both of these areas in a cost-effective fashion, and has the potential to provide an opportunity for students to place many of these issues into perspective at the close of their undergraduate experience.

Conclusion

In this paper, we have discussed the results of a pilot study to conduct an outcomes assessment in a medium-scale state university computer science program. Our assessment instrument was breadth-oriented, meaning that we were attempting to assess student knowledge of facts spanning the breadth of the computer science discipline. Our results are threefold:

- Graduating seniors have a degree of breadth knowledge roughly consistent with what one would expect, given the quality of students surveyed.
- The introductory breadth course does not provide breadth knowledge equivalent to what seniors obtain after taking several advanced depth courses; however, a substantial amount of breadth material is covered in that course.
- Students have little knowledge of computing history and culture at all levels of the curriculum.

Much future work in this area is needed. In particular, dimensions of quality need to be identified and new assessment instruments need to be developed to measure quality along these different dimensions. We believe that one of these dimensions is knowledge of computing history and culture; a more detailed instrument should be developed measuring this dimension. More studies need to be done to measure the value of breadth-first versus depth-first introductory courses and sequences. Finally, at our institution, we will continue this type of evaluation, and will give particular emphasis to evaluating the success of our senior capstone course in computing history and culture.

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Paper (W3-201B)

Ethics and Computer Scientists

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Abstract

This study undertook to determine whether computer science educators agreed that computer ethics should, or could, be taught; and, if so, the topics to include and the best method for teaching computing ethics.

Most educators agreed that computer ethics could and should be taught at the college level, by computer science educators, using a variety of teaching techniques, especially lecture and case studies.

Introduction

The account of a Cornell University computer science student who brought computer systems at MIT and other universities, the RAND Corporation, and NASA to a grinding halt (Forester & Morrison, 1990, p. 57) was an extreme example of the potential for wrongdoing when misusing a computer. While the potential has always existed for unethical use of computers, the widespread use of computer networks has greatly magnified the potential harm that such unethical computer use can generate.

In light of a concern about the possibility of utilizing computer technology for unethical means, the Computer Science Accrediting Board (CSAB) has required that colleges and universities must be able to document that computer ethics and values are included in the curriculum in order to receive CSAB accreditation. Most schools must change their curriculum to assure that they include a discussion of ethics and values for CSAB accreditation.

Computer ethics includes an assortment of concerns: software piracy; invasion of privacy; inaccurate data, either through sloppy validation procedures or deliberate misrepresentation of data; use of computers to commit a variety of crimes, such as embezzlement; and computer viruses, our newest highly-publicized concern. But there is no real agreement on the definition of computer ethics, what concerns it encompasses, or whether it can or should be taught in the college classroom.

Even among those who feel strongly that computer ethics can and should be taught in the classroom, there are differences of opinion as to whether these topics should be taught in a separate course or integrated within the computer science curriculum. A course emphasizing computer ethics is likely to look at the larger area of societal issues in computer applications (Gotterbarn, 1991). It probably includes reading of several treatises on the topic and a good deal of classroom discussion. It may also include students writing about the topics read and discussed and a practical application of the principles covered in the classroom.

Ethical Implications of Computers

Computers are tools which can have a tremendous impact on lives, either positive or negative. Used properly, sophisticated computer data bases can aid in apprehending dangerous criminals (Shannon, 1987) or in protecting government agencies from individuals who are abusing the system. But abuse of data base searches, often in the form of uninformed negligence, can cause innocent people to lose their welfare payments, be denied credit, receive threats over other people's obligations, and even be imprisoned wrongly (Davis, 1987). Artificial intelligence, one branch of computer science, can be used to provide sophisticated, user friendly teaching aids for students. or the same technology can be used to guide missiles capable of annihilating entire populations (Weizenbaum, 1986).

Society can not afford to worship the computer blindly nor to denigrate it prejudiciously. The potential for unethical behavior in the use of a computer seems to be clear, whether we are talking about large issues such as the planning of nuclear war, clearly criminal cases such as embezzlement, or more subtle issues such as reading another's personal data without permission. The question remains, however, as to how we should deal with computer ethics in the classroom.

Purpose of the Study

The purpose of this study was to explore the perceptions that computer science educators have about computer ethics. In the field of computer science, almost every topic of discussion is still a relatively new one. But ethical conduct is an ancient concept which has dictated standards of behavior for thousands of years. In particular, the opinions of college-level computer science instructors were examined in order to find a common ground on how ethics should be applied within the new technology of computer science.

Questions to Guide the Study

The following questions guided this study of computer ethics:

1. To what extent do computer science educators believe that ethically inappropriate practices are taking place (both on their own campus and throughout society generally)?

2. What are the perceptions of computer science educators about which practices in computer science have ethical connotations?

3. To what extent do computer science educators perceive that computer ethics are an appropriate topic to be addressed in computer science classes? Which topics with ethical implications should be taught in the classroom?

4. If computer ethics is taught at the college level, what teaching methods should be used?

Population and Sample

All 144 full-time faculty members who teach computer science classes in any college or university in the author's state which offers a bachelor's degree with a major or minor in computer science were surveyed. Computer related courses are taught under a variety of titles i a wide range of departments. Therefore, the sample was found in departments such as computer science, finance and management information systems, math and computer science, computer studies, computer information systems, and engineering math and computer science. They may be i the college of arts and sciences, business, engineering, or science, technology, and health.

Responses were received from all eight state universities and 11 church-related and private schools. The 87 faculty members who responded to the first request or within three weeks of the second mailing mad up the sample.

Analysis of Data

The analysis of data is divided into four parts, each one corresponding to a research question that guided the study. The instrument itself is divided into a section for demographic data followed by three parts intended to answer the guiding research questions. The first par asked general questions about computer ethics and computer ethics education. Questions in Part II were predicated on the assumption that the respondent has been given the authority to design a computer ethics course. The third part provided the participant with an opportuniy for open-ended responses.

Question 1

To what extent do computer science educators believe that ethicall inappropriate practices are taking place?

Educators were asked whether they believed that computer ethics is a problem globally and at their institution. The answer to both these questions was yes, but to varying degrees. Seventy-two (85%) of the respondents felt that computer ethics was a global problem, but only 44 (54%) considered computer ethics a problem at their institution.

Participants indicated the extent to which they felt that ethically inappropriate computer practices are commonly taking place among certain groups (Table 1). Possible responses were strongly agree, agree, neutral or no opinion, disagree, or strongly agree. Means analysis was performed after assigning numeric values to responses, giving 5 for strongly agree, down to 1 for strongly disagree. For each group of people mentioned, the mean value was more than 3.0. The general consensus was that students are more likely to engage in unethical practices than.faculty. Computer science students were ranked highest, with a mean of 3.80, followed by other college and university students, with a mean of 3.64. Faculty members were ranked as the least likely to behave unethically, with a mean of 3.31 for non-computer science faculty, and only 3.04, for computer science faculty.

Group	SA Freq %	AFreq %	*N* Freq %	D Freq %	SD Freq %	Mean	Std Dev
C.S. students	13-15	51 -60	14 -7	5 -6	2-2	3.80	0.86
Other college & university students	13-15	42-49	18-21	10 -12	2-2	3.64	0.96
Individuals who use computers as part of their jobs	10-12	42-50	24 -29	7-8	1-1	3.63	0.85

Operators of bulletin board systems	1619	28 33	33 39	6 7	1 1	3.62	0.91
Computer professionals in business & industry	2-14	39 46	21 25	11 13	1 1	3.60	0.93
Computer clubs or local interest groups	12-14	32 38	32 38	6 7	2 2	3.55	0.91
other faculty	10-12	24 29	38 45	9 11	4 5	3.32	0.98
computer science faculty	5 6	21 25	36 42	18 21	5 6	3.04	0.97

Table 1 Extent of Unethical Practices: Indicate the extent to which you feel that ethically inappropriate computer practices are commonly taking place among the following groups.

Question 2

What are the perceptions of computer science educators about which practices in computer science have ethical connotations?

Two instrument items addressed this question. The first presented 25 topics and asked each person surveyed to "indicate the extent that you feel each topic is an important ethical issue." Topics were rated from severe issue to not an issue. Values were assigned for this item, with 5 for a severe issue down to 1 for not an issue. A free-form question in Part III asked about the respondent's observation of inappropriate computer practices.

I A mean was calculated for each suggested topic, ranging from highs of 4.28 for accessing confidential databanks and 4.27 for copying commercial software to lows of 2.57 for boredom from routine and 2.56 for computer aided instruction (Table 2). More than half (minimum of 46) of those surveyed felt that 23 of the 25 topics were at least a moderate issue. Fifteen topics had a mean response of more than 3.0.

Four people responded none or zero to the question, "In your teaching of computer science, what unethical situations have you encountered?" Another 13 gave no response to the question, which was interpreted to mean that they had not encountered any unethical situations. About half of the respondents (43) named one unethical situation they had encountered. Others mentioned as many as eight different situations, with one given as "and lots more." The overall mean was 1.36 situations. Similar responses were grouped together for purposes of analysis. The largest group (41, or 47%) listed piracy or copying of copyrighted software as unethical situations that they had encountered. Another 33 (38%) listed plagiarism and cheating, such as copying another student's programs or homework. Hacking and/or security violations were mentioned by 14 people, or 16% of those surveyed.

Topic	Frequency							
	5	4	3	2	1	Mean	Std Dev	Rank*
h)Accessing confidential databanks	45	23	14	2	1	4.28	0.908	1
g)Copying commercial software	39	33	10	3	0	4.27	0.808	2
v)System security	33	33	16	1	1	4.14	0.852	3
f)Use of computers to commit crimes	39	27	13	4	2	4.14	1.002	4
t)Viruses and worms	28	36	15	5	1	4.00	0.926	5
u)Monitoring electronic mail	21	37	21	5	1	3.85	0.906	6
x)Electronic transfer of funds	23	34	16	6	6	3.73	1.148	7
w)Networks	17	38	18	8	3	3.69	1.018	8

i)Validity of data(GIGO)	18	29	30	6	2	3.65	0.972	9
y)Military applications	25	27	17	9	7	3.64	1.243	10
j)Reliability of software	15	30	30	7	3	3.55	0.994	11
l)Adult hackers	18	27	22	18	0	3.53	1.053	12
e)social responsibility	15	29	26	7	7	3.45	1.134	13
b)Databanks on suspected criminals	15	32	20	9	8	3.44	1.186	14
k)Teenage hackers	12	30	25	17	1	3.41	1.003	15
s)"Whistle-blowing"	6	17	36	10	16	2.85	1.160	16
p)On-the-job stress	5	23	20	24	12	2.82	1.163	17
c)Gender-related issues	6	21	27	12	19	2.80	1.242	18
q)Worker displacement resulting from computers	5	18	28	22	12	2.79	1.114	19
n)Potential VDT health risks	6	19	23	23	14	2.76	1.182	20
d)Minority issues	3	21	28	16	17	2.73	1.148	21
a)Effect of computers on socialization skills	5	18	24	22	16	2.69	1.175	22
o)Boredom from routine	3	16	22	28	15	2.57	1.101	24
r)employee loyalty	4	11	31	23	15	2.60	1.077	23
m)Computer Aided Instruction	8	16	16	20	25	2.55	1.341	25

* I = highest rank 25 lowest rank

Table 2. Importance of Ethical Issues: Indicate the extent that each topic is an important ethical issue.

Question 3

To what extent do computer science educators perceive that computer ethics is an appropriate topic to be addressed in computer science classes? Which topics with ethical implications should be taught in the classroom?

The great majority of those surveyed believed that computer ethics should be addressed in some manner at the university level, but there was less agreement on requiring a computer ethics course or including computer ethics in the curriculum below the university level. Seventyeight (92%) of those responding, agreed that a school or department should develop and publish its own computing ethics policy. Even more people (77, or 94%), believed that the ethical use of computers can be taught.

Most respondents (61, or 70%) indicated that including computer ethics in the curriculum at the college or university level is of extreme importance or great importance (Table 3). A smaller majority (49, or 56%) considered it to be of extreme importance or great importance to include computer ethics at the high school level. Respondents were divided over the importance of including computer ethics in the middle school curriculum and less enthusiastic about including computer ethics at the elementary school level, ranked to be of extreme or great importance by 30% and 24%, respectively.

When not pressed for a specific level, four out of five participants agreed or strongly agreed that we should teach computer ethics in a classroom setting. Almost as many agreed or strongly agreed that an institution with an ethics course should ask faculty to discuss the topic in other courses as well. There was no such consensus about whether a computer ethics course should be required (Table 3).

	SA Freq %	A Freq %	*N* Freq %	D Freq %	SD Freq %	Mean	Std Dev
Should teach computer ethics in classroom	24 35	31 45	10 15	4 6	0 0	4.09	.85
Should discuss computer ethics in other classes	30 35	36 42	14 17	5 6	0 0	4.07	0.87
Should require course	11 13	17 20	24 28	17 20	16 19	2.88	1.30

* To calculate mean and standard deviation, responses were assigned numeric values: S A = 5, A = 4, *N* = 3, D = 2, SD = 1

Table 3. Computer Ethics in a Classroom Setting

The instrument includes a list of possible topics for inclusion in a computer ethics course and asks those surveyed to select the topics that they would include in such a course. Educators selected the topic which they considered the most important. Respondents also were given an opportunity to suggest other topics that they would include in a computer ethics course and to describe computer ethics courses taught at their institutions.

Respondents identified the ethical issues they would like to see integrated into a computer ethics course. For each selected issue, respondents then indicated the teaching method they would like to use to present the topic. Only the selection or rejection of a topic is discussed here; teaching methods are discussed below in the section for question 4.

Eighty educators (96%) agreed that the topic of copying commercial software should be included in a computer ethics course if one were offered (Table 4). Boredom from routine was the least likely to be selected; it was chosen by 32 (41%) of those who responded to the question.

Educators were asked, "From this list, what do you consider the single most important ethical issue facing computer professionals today?" (Table 5). Copying commercial software was named most often, by 18 respondents. Ten people named social responsibility as the single most important ethical issue, 9 selected accessing confidential databanks, and 8 named the use of computers to commit crimes. Fourteen other topics received at least one vote.

Question 4

If computer ethics is taught at the college level, what teaching methods should be used? Which methods should be used on which topics?

From this list, what do you consider the single most important ethical issue facing computer professionals today?

Topic	Freq	%**	Rank*	Votes MostImp
g)Copying commercial software	80	96.4	1	18
t)Viruses and worms	78	95.1	2	4
h)Accessing confidential databanks	77	93.9	3	9
v)System security	76	93.8	4	7
f)Use of computers to commit crimes	75	90.4	5	8
u)Monitoring electronic mail	75	91.5	6	1
e)Social responsibility	67	82.7	7	10

l)Adult hackers	63	79.7	8	2
x)Electronic transfer of funds	63	78.7	10	1
w)Networks	63	77.8	11	1
k)Teenage hackers	61	76.2	12	3
j)Reliability of software	60	75.9	13	3
b)Databanks on suspected criminals	57	70.3	14	
s)"Whistle-blowing"	55	68.7	15	
q)Worker displacement resulting from computers	52	65.9	16	1
a)Effect of computers on socialization skills	51	63.7	17	1
y)Military applications	50	64.1	18	1
n)Potential VDT health risks	44	54.3	19	
p)On-the-job stress	43	54.4	20	
c)Gender-related issues	41	70.3	21	2
r)Employee loyalty	41	51.9	22	
d)Minority issues	36	45.6	23	
m)Computer Aided Instruction	34	43.6	24	
o)Boredom from routine	32	41.0	25	
z)Other	11		26	1

1 = highest rank 25 = lowest rank % based on those who responded for each topic, ranging from 78 to 83

Table 4. Rank Order for Topics for Computer Ethics Course: Indicate the topics from the following list that you would like to see in the computer ethics course.

When asked where to place the teaching of computer ethics, the largest group of respondents (30, or 35%) preferred to include computer ethics "as a separate module in a larger course" (Table 5). The separate module format also received the highest mean value (3.62). The second most popular placement was "through personal example of faculty and staff," with a mean of 3.42 and 24 respondents (28%) selecting it first.

Placement in Curriculum	5 Freq %	4 Freq%	3 Freq %	2 Freq %	1 Freq %	Mean	Std Dev
Course Module	30 35	14 16	24 28	13 15	4-5	3.62	1.34
Example of faculty & staff	24 28	23 27	21 25	10 12	7-8	3.55	1.25
References in C.S. curriculum	12 14	29 34	16 19	24 28	4-5	3.25	1.15
Separate C.S. course	13 15	13 15	11 13	16 19	32-38	2.52	1.50
Ethics course in another dept.	6 7	5 6	20 24	14 17	40-47	2.09	1.26

Table 5. Curriculum Placement for Computer Ethics: Rank the following placements in the curriculum for teaching computer ethics at the college level, with 5 being the highest ranking and 1 being the lowest ranking. (Use each value once.)

Computer science educators believed that they were the group best suited for teaching a computer ethics course, either alone or as part of a team (Table 6). Asked to "rank the following groups according to which you consider the most appropriate for teaching the computer ethics course," respondents ranked computer science faculty first, with a mean of 3.88 and 33 (40%) first-place votes. The choice of a team of computer science and other faculty ran a close second, receiving 32 (38%) first-place votes and a mean of 3.87.

Faculty Group	5 Freq %	4 Freq%	3 Freq %	2 Freq %	1 Freq %	Mean	Std Dev
C.S. faculty	33-39	24-29	16-19	6-7	5-6	3.88	1.18
Team of C.S. & other faculty	32-38	33 39	4-5	6-7	9-11	3.87	1.29
Ethicists	7-8	10 12	28-33	19-23	20-24	2.58	1.21
Philosophy/religion faculty	5-6	13 16	21-25	26-31	19-23	2.51	1.17
Sociology faculty	2 2	6 7	26 31	25 30	25 30	2.23	1.03

Table 6. Appropriate Group to Teach Computer Ethics: Rank the following groups according to which you consider the most appropriate for teaching the computer ethics course, with 5 the highest ranking and 1 the lowest.

In response to instrument the question "At what level should the course on computer ethics be offered?" more than half (46, or 55%) recommended that it be offered to freshmen. The course was generally considered more important at lower levels, with sophomores, juniors, and seniors receiving 28, 18, and 13 responses, respectively. (Some people selected more than one level.)

Method	Frequency								
	7	6	5	4	3	2	1	Mean	Std Dev.
Class discussion of case studies	46	18	9	3	1	3	3	6.01	1.56
Individual assessment of case studies	13	28	15	11	7	7	2	5.00	1.62
Lecture by instructor	15	4	16	11	11	4	23	3.77	2.19
Written reports on research	0	14	10	20	16	19	5	3.63	1.52
Group projects	3	7	12	18	17	19	7	3.50	1.57
Oral reports on research	4	5	15	13	23	10	14	3.43	1.67
Group reports	0	6	14	16	12	14	21	3.07	1.65

Table 7. Preferred Teaching Methods: Rank the following teaching methods to use in teaching a computer

Respondents were asked to "Rank the following teaching methods to use in teaching a computer ethics course" (Table 7). Of the suggested ethics course, with 7 being the highest ranking and I the lowest methods, class discussion of instructor-provided case studies was selected by a majority (46, or 55%) as the best method, and also received the highest mean response, of 6.01.

worms, and accessing confidential databanks were ranked as the most important topics to cover. Case studies were selected as the most appropriate means for teaching computer ethics in the classroom, in general. But when asked about the preferred method for teaching specific topics, lecture edged out case studies, which were still popular. There was also a consensus that more than one teaching method was preferrable.

Interestingly, while computer science faculty members were considered to be a particularly ethical group, their students were considered to be particularly unethical. Perhaps this is attributed to abundance of opportunity without the corresponding maturity and awareness of the issue. Educators agreed that an institution should develop and publish a computing ethics policy.

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Paper (W3-202A)

WIRELESS Computing in Schools: Reach out and Touch the World

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Abstract

Many elementary and secondary schools tie in with local colleges and universities and use modems to access the computing power available at these higher education facilities. To help alleviate the financial burden of long-distance phone charges, work has begun on a project to use shortwave radio for computer communications in rural areas. This paper discusses the motivation, implementation, hardware requirements and applications of the WIRELESS (Wireless Radio Experiment Linking Educational Systems and Services) environment.

Introduction

Computers have steadily been added to American schools since the early 1980s and have been valued for their motivational ability and classroom enhancements. Over the last decade the number of computers and terminals in United States schools has increased nearly fifty times. With the emergence of networking, the functionality of these computers could be increased greatly, but access to many networks is limited because of dropping budgets. Many school districts have found partial assistance by cooperative ventures with local higher educational facilities and can use the computing facilities at the local universities and colleges. To do this, the schools require a link via the phone lines (using modems) to some host university. This implies, in several cases, long-distance phone charges.

Many schools, particularly rural ones, would like to use the computing power available via neighboring universities, but they are hindered by the high cost of long-distance phone calls to access these computer centers. Some schools can pay the necessary long-distance charges for this access, but many schools cannot fit even this seemingly nominal charge into an evershrinking budget. Moneys appropriated for hardware, such as computers and modems, often run out before the hardware can be effectively used, and the fact that phone charges are a continuing cost only serves to compound the problem.

To help alleviate this difficulty, work has begun to use the airways instead of the phone lines for computer communication. An interest in shortwave radio and a concern for rural education led to the idea of using shortwave radio to help impart knowledge to schools practically free of charge via the WIRELESS project (**WI**reless **R**adio **E**xperiment **L**inking **E**ducational **S**ystems and **S**ervices).

Wireless communication is certainly nothing new. Wireless telecommunications networks are showing up everywhere [5,6,7]. The advent of the cellular phone has prompted the design of personal communication systems (PCSs) and personal communication networks (PCNs) [3,4,8]. People may see cellular phones, portable faxes and modems, pagers, personal organizers and hand-held workstations all integrated into a single pen-based unit that operates in a wireless communications matrix. These new systems are limited only by the allocation of the required frequency spectrum. (The Federal Communications Commission (FCC) is currently undergoing frequency allocation modifications.) Some experiments are being done to use this technology in education. Students in Spain are able to exchange ideas and work using radio electrical space for communications [2]. The WIRELESS project extends this idea by allowing elementary and secondary schools access to university computing resources via shortwave radio.

Motivation and Implementation

A love for amateur radio and an awareness of the new wireless communications revolution led to an idea: why not use radio instead of phone lines to allow logins to the computer system? Long-distance phone calls could be eliminated, thus changing an on-going cost into a one-time fee for purchase of radio equipment only, and could hopefully open up new doors for some districts. Wireless communication could also free up telephone resources that are being allocated to modem communication.

As an example of the savings possible, consider a typical month of dial-in activity at Northwest Missouri State University. Elementary and secondary schools log in via modems and phone lines to access both library holdings and Internet utilities. Statistics gathered indicate that schools making long-distance calls spend approximately 323 minutes per month on the system, resulting in a cost of $54 per month. Typically, only one person at the remote site accesses the university computer, which results in a minimum of log in sessions. This is due to the cost of long-distance. However, the usage for schools in the local calling area is about ten times greater than that of the schools making long-distance calls. If the local schools were calling long-distance, this would imply charges of approximately $540 per month. These figures indicate that the long-distance phone charges have a definite impact on computer use. Wireless communication will not only eliminate these long-distance charges, but will also encourage more usage and increase student and teacher participation.

Preparation for this project began in 1992. First, a study was done to determine if this idea was feasible, and then some investigation was performed to determine if the idea would be acceptable to local schools. Research on the topic revealed some work was being done in this area, but none was apparently being done to the extent intended with this project. A grant proposal was written requesting local university money that would allow acquisition of the necessary equipment. Moneys were acquired for hardware at both the university and the rural school selected as the beta test site. Determination of the beta site was done by first selecting a group of schools within the limited range of the initial test equipment and by interviewing the school administrators.

Hardware

The initial hardware consisted of an antenna, a terminal node controller (TNC) and a radio at both the beta site and the host university site. The university was equipped with a base amateur 2 meter radio while the beta site was set up with a mobile unit on the same frequency. The university radio was hooked up to a port on the mainframe via the TNC, while the beta site used a microcomputer with its TNC. Initiating a communication was similar to using a phone line and modem, with only a few protocol changes. Instead of phoning up the university, the operator at the beta site initiated a session via radio, and instead of using the modem, the remote operator began the communication session by activating the TNC. The connection was accomplished by issuing a connect command to the call sign of the operator at the host site.

Originally, it was necessary to have a licensed operator at both the base and the beta site because amateur packet radio was being used. This required someone at both the beta site and the host site to take a test to obtain the appropriate license. The project has since changed the type of radio in use. One obstacle was the FCC regulation stating that no business can be conducted over packet radio. The original intent of the project was to allow the schools to log into the university computer system to access the library card catalog system. After an initial trial period, the project was going to expand to allow access to various other services, including access to the Internet via telnet (remote login) and ftp (file transfer protocol) sessions. However, because of FCC regulations, access to the Internet was a definite problem — even the library access was questionable. After considerable investigation into the matter, including inquiries directed to the American Radio Relay League (ARRL), no definitive answer was provided for the question: was accessing the library a business communication or not?

Because of the uncertainty of using packet radio for this communication and the possible revocation of operator licenses, the project turned to business shortwave radio instead of amateur packet radio. This conversion caused several changes in hardware at both sites and in the licensing of the operators. Because the business shortwave band was at a different frequency, the antennas had to be changed and new radios had to be purchased. The original packet radio hardware was set up to operate at 2 meters (145 MHz), and the new business band equipment operates at frequencies in either the 400MHz range or the 800MHz range. The TNCs are no longer required as the function performed by these units has been placed in a small card that can be placed in the computer. The remote site must have a PC compatible computer (286 or better) to place this card into, which in turn hooks to a radio the size of a cigarette pack. The power supply for this set up is the PC itself.

The university was awarded a large Department of Elementary and Secondary Education (DESE) grant to continue this project, and the plan changed to allow approximately twenty area schools access to the local computing resources, including telnet and ftp sessions, via shortwave radio. The business band equipment operating in the 400MHz range allows communications at 9600 baud within 15 miles and costs approximately $600/site. These costs include the card, radio and necessary software to connect and operate the PC in this environment, but do not include the cost of the antenna, wiring or grounding (which is approximately $200). Longer range communications (15 miles and more) are accomplished by adding radio amplifiers at the host and remote sites.

The university host site requires a slightly different setup than the remote sites. A hub, allowing four radios to connect to the host computer, acts as a router to the Internet. Connection ports are on different frequencies to help alleviate traffic. There are two possible configurations that can exist between the host and remote sites. Currently, we have each PC at the remote sites communicating directly to the university host computer, which in turn, broadcasts to the Internet. It is possible to dedicate a PC with an Ethernet card at a remote site to function as a router for a network of PCs. This would allow each computer in a roomful of PCs to individually access the Internet by using this routing PC as a liaison to the university connection.

Because of the change to a business frequency, the university site and the remote sites are no longer required to have licensed amateur radio operators present. The new frequency requires the host university to possess the FCC license rather than the individuals operating the equipment and a license for each remote site, along with exact longitude and latitude coordinates for each site (host and clients). Remote sites also have to have a license to operate this equipment. The host license costs $175 and each remote site license is $135.

The real advantage to this change is that the university is no longer limited to what it can do — essentially any communication is allowed over these bands. As an example, consider many of the Internet news groups. Several "advertise" equipment or various items for sale, or post job openings or resumes. This type of communication is definitely off limits for amateur packet radio users, but poses no problem over the business band.

Applications

To use this method of computer communication, the school simply turns on the microcomputer and the radio and either performs a telnet session or an ftp session. At this point the connection to the university computer will be made. Once a connection is made, the faculty member or student at the school can type at the keyboard as if a modem were being used, with the only difference being that the phone lines are not involved. It must be stressed that the fact a radio is being used instead of a modem and phone line (or a direct, wired connection to the host computer) is totally transparent to the user.

There are many applications for this particular setup. They are, in fact, the same ones that could be used if the school were accessing the university computer system via a regular modem or as a node on the Internet. The only difference is that for each particular application used with this shortwave setup, a specific software package is required to accommodate the application. For example, to telnet to the university, telnet software is required, and to transfer files, ftp software is required. The majority of these software packages are public domain and available at no cost. This project allows schools with declining budgets to access the university computer at essentially no cost. Once the hardware is in place, the communication is free. As mentioned previously, the initial goal, now a reality, was to allow access to the university on-line card catalog and other local library services. This allows the students at the schools to make use of the university library, while also promoting computer literacy and giving the student a larger collection of resources.

With the advent of the Internet, the resources available to university students have become almost infinitely large, and those same resources are now available to elementary, junior high and high school students having the necessary equipment to use shortwave radio. Students or faculty members from the remote sites can log into a special WIRELESS account, either one created for a class or one created for an individual. They can then telnet to a wide variety of locations with even more applications or ftp to various sites to retrieve public documents or software. Many of the telnet and ftp sites offer on-line books and periodicals with the ability to E-mail sections or articles.

Certain limitations have been placed on these communications. Any local schools (within the local calling range) are not allowed access to the university computer system via this method — it is reserved for those schools requiring long-distance communication. Only schools that have made prior arrangements with the university are able to access these special lines for radio communication. Other limitations to consider include maximum time limits per login session, inactivity time limits, and possible login scheduling to provide equal access to computer resources.

Advantages of Wireless Communication

There are several advantages of communicating via a wireless connection instead of a land-line based communication medium. The most important of these is CO$T. Table 1 indicates the point at which the wireless communication environment becomes less expensive than a land-line environment. Assuming a personal computer at the site and phone lines currently in place, the startup cost for using a phone line includes $200 for a 9600 baud modem and $50 for terminal emulation software, for a total of $250. Continuing costs, assuming two hours of computer access time per school day, average $80 per month. Assuming a personal computer at the site, the start up cost for using wireless communication includes $600 for the radio, card and software, and $200 for wiring, antenna installation and grounding, for a total of $800. The wireless communications connection pays for itself within eight months of use.

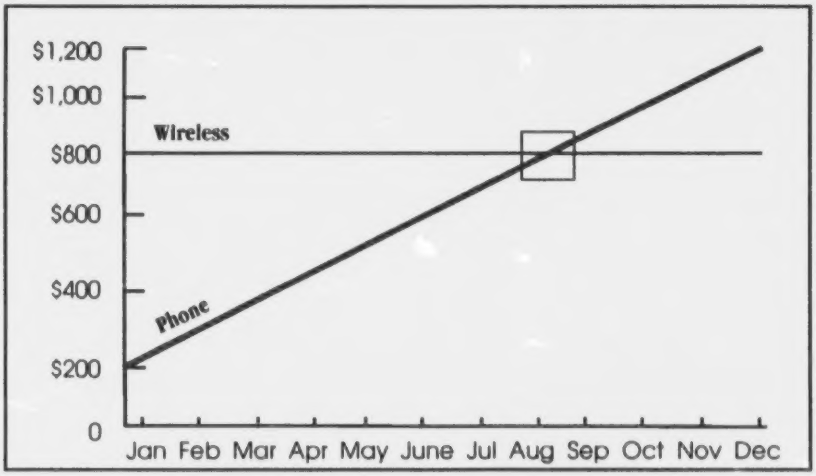

Table 1. Wireless vs. Phone Line Cost Projection

Another advantage of wireless communication arises when considering the connection of a remote local area network (LAN). In a land-line based environment, to attach a LAN of twenty personal computers, twenty separate phone lines and modems would be required to allow each computer to connect to the Internet. However, only one wireless connection is required to connect up to forty personal computers to the Internet. One personal computer is required to be a dedicated wireless server, and only this computer must have a wireless interface.

Conclusion

Reports indicate [1] computer acquisition is continuing to take a larger portion of the instructional and equipment dollars, yet only a small fraction of teachers and students are major computer users. With the advent of the Internet and exposure to it, more people, both teachers and students, could become more proficient computer users, learning to use the computer as an information organizing, storage and retrieval device as well as a valuable research tool. The university currently offers courses teaching people how to access the Internet and how to make full use of its resources in various areas.

Phase I of the WIRELESS project allows for elementary and secondary schools to access the computing facilities at the university, including the Internet connection. This project has been a stepping stone for statewide networking — the results from this project will be evaluated and used as a model for future networking in the state.

Plans for Phase II of the project include downloading information from satellites, storing it at the university, and then allowing access to this information by the remote wireless sites. This would allow the sites to do local, real-time imaging.

New technology should be available for everyone, and too often, especially for smaller rural schools, the long-distance charges have made it impossible to utilize the resources available to them. The WIRELESS project is a practical solution to this problem — one that can be implemented today, at a reasonable cost, with little or no training.

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Paper (W3-202B)

Inexpensive E-mail Systems for LANs and Dial-up

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Key words: UUCP, Linux, electronic mail, Eudora, NUPop

Abstract

Access to Internet E-mail is becoming easier to find for K-12 teachers. Many colleges and universities will give accounts to teachers for the price of asking. Unfortunately, many of these university systems are hard to use and are usually not offered to K-12 students. Most schools do not have phone lines in classrooms. This paper will discuss two systems that will enable you to use your school's LAN—and a 386 with one modem—to give an Internet E-mail account to anyone you like. The necessary software is either inexpensive or free. The two systems discussed are Waffle, an MS-DOS bulletin board system, and Linux, a free Unix-like operating system that can act as an IMAP and POP server for programs like PC-Pine, NUPop, and Eudora. Both use UUCP to exchange mail with an Internet host. UUCP packages are available for a number of other BBS and E-mail systems.

What You Need

This paper is for those who have a local area network (Novell, MacTCP, or other ethernet) and know why you want to use E-mail. Once a UUCP connection is set up, it will need little maintenance, but you will want someone at hand who can help solve problems that crop up, since an organization can quickly grow dependent on an E-mail system.

A machine running Linux can additionally handle many dial-up users using Eudora on a Macintosh or NUPop on an MS-DOS machine. Eudora and NUPop are mail readers which make phone calls and send and receive mail at the touch of a key. Such a solution is especially good for a rural district wanting to give E-mail accounts to all of its teachers, since it minimizes expensive long distance charges.

Both of the systems discussed here, Waffle and Linux, use a transport protocol called UUCP to exchange mail with an Internet connected computer. There are a number of other programs for DOS, Windows, and Macintosh that also support

UUCP. UUCP works very much like FIDOnet, but its headers follow conventions of the Internet. There are a number of other UUCP packages, free and commercial, for MS-DOS, Macintosh, and many other BBS and E-mail packages.

What You are Getting

Some teachers who want their students to participate in on-line projects upload messages for students at home, sometimes even re-typing them. With Linux or Waffle each student can have an account, so students get to see what it is like to send E-mail themselves. Students are excited even by sending a message across the room; sending them across the globe is even better. Also, an E-mail system can be a valuable means of communication among teachers in different buildings or with different schedules.

A UUCP connection can give you access to Internet E-mail over a UUCP link. (Actually, USENET E-mail is more correct since the machines are not IP connected to the Internet.) You will be able to send E-mail to anyone on the Internet as well as those using services like CompuServe and America Online, and networks like FIDOnet and FrEdMail. You will also be able to send and receive USENET news. There are currently over 2,000 newsgroups on topics from astrology to zymurgy. Many newsgroups are inappropriate for students, but you will have complete control over which groups you receive, so there is no danger of students reading alt.sex.

The systems described here provide E-mail and news access only, not a live Internet connection. The good news is that you need only have part-time access to a voice-grade phone line. If a line dedicated to the system is unavailable, the software can be configured to use the phone line only after school hours. The bad news is that this kind of connection does not support interactive Internet applications like Gopher, Mosaic, telnet, and ftp. (You *can* use these applications, but only to connect to your own server.) There are ways to access much of the same information using only E-mail, but it is not as fun, as fast, or as convenient.

A benefit of using UUCP is that you need only one modem; that modem is controlled by a computer, minimizing time online, and users of the system do not need direct access to the modem. You will not have to worry about students launching missiles or making long distance calls. You will not have to worry about training everyone to use modems. And you will not have to worry about begging a university administrator or paying a commercial service every time you want another account. You will also gain the power to set up your own mailing lists and newsgroups.

How Does it Work?

First you arrange for a "feed." A feed is a computer connected to the Internet that agrees to accept mail for your computer and hold it until your computer calls to pick it up. Often schools can get a free connection from a local college, university, or business. Your computer will call (or "poll") your feed as often as you can afford, from hourly to daily. When your computer connects to your feed, the mail written at your site is sent to the Internet and mail from the Internet is transferred to your computer. It all happens automatically. No one needs to be there to watch or even press a key.

A user on either of these systems will access their E-mail with a program running on a computer on the LAN, not over a modem to a mainframe. The user can then read and write E-mail and USENET news without using a modem and without concern that a clock is ticking. Since the program is running on your computer, it responds immediately, not delayed as over a modem. When a user "sends" a message it actually waits on your server until the next time your server polls. Messages sent to others at your site are delivered immediately.

Waffle

Waffle is a BBS that runs under MS-DOS. It is designed to be used as a dial-up system—it can answer the phone and let people log in. It can also be used on a Novell (or other) LAN. Its standard interface is somewhat old-fashioned, but it is probably no more so than other BBS or university systems that you may be using now. There are also several easy to use add-on programs that provide a friendly user interface.

If you use Windows, you can replace Waffle's command line oriented user interface with a program called Helldiver. Helldiver allows users to use familiar mouse movements and menus to select and read E-mail messages.

Waffle can be licensed by K-12 schools for $30. Helldiver is free.

Linux

Linux is a Unix-compatible operating system developed by Linus Torvalds of Finland and several hundred others on the Internet. It completely replaces MS-DOS and has all of the features one would expect of a Unix system---from multitasking to networking to cryptic commands like "ls," "rm," and "login." Linux is developed by people in several countries who are able to work together because they have access to the Internet. Version 1.0 should be out by the time this paper is presented; in spite of what a version number of "1.0" often suggests, many have been using Linux as their primary computing environment for over a year now, and it is already a quite stable system. Linux is not a commercial system, but is quite reliable and is continually improving. Several commercial vendors distribute and support Linux.

All of the PC (and Mac) programs discussed here are free unless explicitly stated otherwise. The client programs discussed here will work with any TCP/IP software currently in place. Sites using ethernet need not have any other networking software to use these programs.

LAN Client Applications to Use with Linux

For most people the best way to use Linux is to use Pine, Eudora, or NUPop, client programs that run on computers (MS-DOS, Windows, or Mac) on your LAN and communicate (usually unnoticed by the user) with the server (the Linux machine) with protocols like POP-3 and IMAP. These programs have the advantage of behaving like local applications on the PC, since they are. They do not require logging in to a strange system and learning a new set of commands. Those who want to log in and learn how to use UNIX, may; some students will be excited to learn about a new and powerful operating system. Though some programs support other networking environments, all of the MS-DOS programs discussed here work using "packet drivers" a standardized networking interface. Free packet drivers are available for most ethernet cards.

PC-Pine

PC-Pine is an MS-DOS IMAP client. IMAP is an acronym for Interactive Mail Access Protocol which allows access to a mailbox over a network. Unlike the POP protocol (discussed below) it keeps mail on the server and allows remote access to the mailbox and folders where messages can be filed. This is a plus in situations where people often use a different computer (as in a lab) or are not allowed to store information on local disks.

Pine was originally based on another mail program called Elm. It was developed by people at Washington University who wanted an easy-to-use mail program for their students and faculty. It has a full screen editor, simple menus, and can make use of a mouse on a PC. It also allows files to be attached so that word processing or database files may be included with all formatting information intact.

NUPop

NUPop is an MS-DOS POP-3 client. POP is an acronym for Post Office Protocol. It allows for a program to manipulate a mailbox on a remote computer. NUPop was developed at Northwestern University, and has been in everyday use there. It has the menu and multi-window interface that people have come to expect and makes good use of a mouse. It allows messages to be stored in folders for easy access later and has a full screen editor that users find intuitive.

Eudora

Eudora is a Macintosh POP client (there is a windows version as well). It works just like a Macintosh program is expected to, with a familiar editor and the ability to cut and paste. It was developed at the University of Illinois in Urbana-Champaign and is used widely there and at other universities. There are two versions of Eudora, a free version, and a commercial version which can automatically sort incoming mail according to criteria that you choose. For instance, it can put mail from mailing lists that you subscribe to into separate folders, saving you from a cluttered mailbox.

Off-line Reading

In addition to being useful over a LAN, both Eudora and NUPop can be used to dial-up your Linux machine, get your mail, send any mail written off-line, and hang up the phone. Otherwise, the programs function as directly connected to a LAN. Since the phone call is automated, on-line time is minimized (usually less than one minute). These off-line readers are a good solution for a group of people (in a district or school system) who are not connected to a LAN, but want to provide E-mail access for many people. They are also good solutions for rural teachers.

Choosing between Waffle and Linux

Though both Waffle and Linux support UUCP, they are very different systems. Waffle is an MS-DOS program that you can install on your network. Aside from learning about UUCP and Waffle, you will not have to learn about a new operating system or change anything in your current LAN setup.

Installing Linux, however, is a somewhat greater undertaking. You will have to learn a new operating system and how to configure it to work with your current systems. In spite of the increased learning curve for the administrator, there are many advantages to installing Linux. Once you have Linux and your workstations configured, you will be ready to connect to the Internet---just plug in a router and you will be ready to go. The time invested in learning about TCP/IP now will pay off later.

System	Linux	Waffle
Cost	Free (CD-ROM available for $30)	$30
Hardware Requirements	386-16, 4MB Ram, 40MB disk	8088, 640K Ram, 20MB Disk
Recommended Hardware	486-33, 8MB Ram, 200MB disk	386, 4MB Ram, 40MB Disk
Advantages	Uses Internet TCP/IP protocols Supports easy to use clients Can support Gopher, FTP, telnet Includes networking software	Uses DOS & current network software Windows users can use Helldiver Easy to install
Disadvantages	Complex operating system Requires dedicated machine	Interface old-fashioned and hard to use Requires networking software and server

Where to Find These Tools

Below are FTP sites where these programs can be found.

- **Waffle**: waf165.zip at wuarchive.wustl.edu (and other SIM-TEL mirrors) in /mirrors/msdos/waffle, also check the comp.bbs.waffle newsgroup.
- **Linux**: First read FAQ at tsx-11.mit.edu in /pub/linux/docs, also check comp.os.linux.announce newsgroup. Since Linux is rather large, you might prefer to get it on CD-ROM.
- **Eudora**: FTP Eudora1.4.sea.hqx at ftp.qualcomm.com in /mac/eudora/1.4.1, also E-mail eudora-info@qualcomm.com or call 1-800-238-3672 for information. The educational price for Eudora 2.0, which offers features that the free version does not, is $25.
- **Pine**: FTP to ftp.cac.washington.edu and read documentation there for information about which version you need.
- **NUPop**: FTP to ftp.acns.nwu.edu and look in the /pub/nupop.

Other sources of information about UUCP, Linux, and Waffle

Managing UUCP and USENET. O'Reilly & Associates. 1992.

"How_to_become_a_USENET_site" is posted monthly to news.announce.newusers and is available for FTP at rtfm.mit.edu in /pub/usenet-by-group/news.announce.newusers

These documents are available in the comp.os.linux.announce newsgroup and are also available for FTP at rtfm.mit.edu in /pub/usenet-by-group/comp.os.linux.announce

- Linux_Frequently_Asked_Questions_with_Answers
- Linux_Ethernet_HOWTO_(Part_1_2)
- Linux_Ethernet_HOWTO_(Part_2_2)
- Linux_Installation_HOWTO
- Linux_UUCP_HOWTO
- Linux_META-FAQ

The documents at rtfm.mit.edu are also available by E-mail. Send a message to mail-server@rtfm.mit.edu with the word "help" in the body.

Summary

If you are looking for a low-cost E-mail connection to the Internet, a free Unix-like system like Linux, or a BBS system like Waffle, may be an answer. They can offer access over your school's LAN or by dial-up. You will have control and can give E-mail accounts to teachers, students, or other people in your community. Linux is able to act as a POP and IMAP server to support E-mail applications like NUPop and Eudora, which are much easier to use than most mainframe mail programs and have the added benefit of allowing users to work off line.

Project (W3-203A)

Literacy in a Science Context for Special Education Students

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Key words: TERC, special needs, mainstream, literacy, learning disabilities, science

Abstract

TERC is working with 5-7th grade mainstream and special education teachers to create technology-enhanced learning environments in which students with learning disabilities can improve their reading comprehension, written and oral communication, and problem-solving skills. Rather than empha-sizing remedial work to address skill deficits, we take the approach that literacy implies an enculturation into ways of thinking, interpreting and using language in a variety of complex activities and settings. We have chosen to look at literacy in a science context , and how students can learn to communicate about their hands-on science experiences. A central issue is why students with disabilities have such difficulty in "learning to talk right", i.e., in mastering the discourse of the formal classroom, both oral and written.

A technology-enhanced Human Physiology curriculum has been developed to allow students with learning disabilities to carry out meaningful science activities both in a technology-equipped resource room and in the regular classroom. Students collaborate to collect and make sense of data about the functioning of their own bodies and communicate orally and in writing about their findings, using the word processor and telecommunications. Technology-based instruction offers some promising trends in the way it capitalizes on the ability of students with learning disabilities to learn in a multi-sensory environment. It allows the preferred modes of individual students to emerge, and enables them to succeed in an academic setting. Microcomputer-Based Laboratories (MBL) consist of probes attached to a computer; this allows students to measure and experiment with various phenomena, such as pulse and respiratory rates. They can record data accurately, store, analyze, and display it in the form of graphs.

Pairs of special and regular education teachers teaching the same students are required to collaborate. Training of participating teachers has included an introduction to the use of the technology tools experience with a project-based, collaborative approach to science activities; an in-depth treatment of data-analysis; participation in a telecommunications collaboration; and cognitive strategy enrichment. Our approach involves a considerable learning experience for special education teachers who have operated in a skill-remediation mode. Most have done no science before this, and some have not used technology before, or have used it for drill and practice. All participating teachers receive a curriculum, on-line telecommunications support, and staff visits. We will report on the impact on teachers, gathered using teacher interviews, teacher seminars, observation of classes, teacher journals, and student work. We will present findings on student progress based on classroom observation and several performance tasks.

Project (W3-203B)

The Potential of Virtual Reality Technology To Improve Science Education

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Key words: virtual reality, science education, immersion interfaces, visualization

Abstract

Those intimately involved with education generally agree that "experience is the best teacher." The sad reality of the educational process, however, is that students are seldom given opportunities for direct experience of that which is to be learned; instead, they often flounder in teaching-by-telling classroom situations. A rapidly maturing technology, first proposed in the 1960s, now offers a novel, unique avenue for the delivery of profoundly situated experiential education to students of all age levels. Usually described as "virtual reality," this technology provides sensory information of such fidelity that the observer can suspend disbelief about feeling "immersed" in an artificial world. Virtual realities not only can simulate real-world environments for learners, but also enable artificial worlds that empower immersive, contextualized experiences previously impossible (e.g. slowing the flow of time during an experiment).

Sponsored by the National Science Foundation, this project is charting the potential opportunities and challenges of virtual reality technologies designed for learning in science. The investigators are integrating a virtual reality user interface (head-mounted display, gesture glove, SpaceBall, etc.) with telepresence, collaborative learning, and visualization techniques to produce a Virtual Physics Laboratory (VPL), a first step toward laboratories for other sciences. Experiments in VPL focus on two themes: 1) remediating common misconceptions about physics based on learners' misgeneralizations of real-world experiences; and 2) giving learners direct, immersive experiences with material difficult to teach in purely abstract form (e.g. Einstein's Theory of Relativity). We will present videos illustrating this work and depicting VPL environments.

Due to the limited nature of the "magic" possible via this medium, one potential problem with the use of virtual environments is the danger of introducing new or unanticipated misconceptions. For example, learners do not feel their sense of personal physical weight alter, even when the gravity field in the artificial reality they have created is set to zero. The cognitive dissonance this mismatch creates, due to conflicting sensory signals, can create both physiological problems (e.g., simulator sickness) and possibly false intellectual generalizations. This project is exploring the extent to which manipulating learners' visual, auditory, and tactile receptors may induce subtle new types of misconceptions about physical phenomena.

Cognitive trials are being conducted with individual learners to research how various aspects of the virtual environment (immersion, visualization, collaboration, contextualized intelligent aids) can be designed to optimize learning. This project's results are establishing the degree to which virtual reality is a useful and affordable instructional adjunct in science education. Over the next five years, as moderate-cost, high-performance virtual reality systems emerge, the outcomes of this research will play an important role in defining subject-independent design principles for the educational usage of virtual reality technology.

Project (W3-204A)

"Making the Grade": An Interactive Video Case for Teaching Ethics

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Key words: interactive video, ethics, laserdisc, case-based teaching, Macintosh

Abstract

We are interested in bringing the technological revolution into the classroom. We would like to use modern technology to make the teaching and learning process more effective, to help us better make use of our time with students in the classroom.

"Making the Grade" is an introductory ethics case which provides students with an ethical decision that is easily understood, interesting, and relevant. The case is designed to introduce the students to ethical reasoning using stakeholder analysis.

Kate is a bright and personable student at a modern university. She is confronted with the loss of her academic scholarship if she does not maintain a B average. Without the scholarship she will have to withdraw from the University. She is getting a C in her calculus course and she asks her professor if there is anything that she can do to raise her grade so that she will not lose her scholarship ...

The case is presented in a series of eight 3 or 4 minutes video vignettes. We meet Kate and her roommate discussing the situation, see Kate talking with her professor, see the professor discussing the matter with a colleague, see other students in Kate's dorm discussing what is fair, see Kate's parents at home, and meet a student who is doing much better than Kate and might get the scholarship if Kate loses it. There is one video segment that discusses ethical case analysis and that presents a standard seven step approach for analyzing an ethics case.

We are preparing three technological formats for presenting the case in the classroom. 1) The vignettes have been recorded on laserdisc for use with a *HyperCard* interface on a Macintosh controller. 2) The vignettes can be used on a laserdisc player with a barcode controller. 3) At the least sophisticated level, the vignettes have been recorded on videotape with places to pause between the vignettes. The first format provides the most flexibility for the instructor, allowing the instructor to present any of the vignettes at any time to the class with a click of the mouse. The third format imposes an order for the vignettes unless the instructor wants to fast-forward on the VCR.

The case was developed for use in a new freshman introductory ethics course at Boston College. We have tried the case in an experimental class using the Macintosh/laserdisc format, with success. An instructor's guide for the case is being developed. We are interested in discussing the project with participants at NECC '94. We will be happy to make our materials available for use at other schools.

Revolutionary Classroom (W3-207A)

Enabling the Future

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Key words: ALPHA, technology, computers, learning

Abstract

Seymour Papert in his latest book, *The Children's Machine* (1992, p.221), has concluded that "The design of a learning environment has to take account of the cultural environment as well, and its implementation must make serious efforts at involvement of the communities in which it is to operate." It was for this reason that ALPHA (Alternative Learning Program: Hope and Achievement) was formed in a rural Virginia school division with five visionary teachers committed to enabling the future for secondary school students.

The ALPHA program is housed in the only county high school and serves 60 to 75 students grades 9-12 who have been identified from previous records as "failures" within the traditional curriculum and lack skills to operate within the larger community. ALPHA is not merely a list of courses and objectives. It is a dynamic and continuing search for how we might better educated those students for whom the traditional system of education has failed.

ALPHA provides a compelling picture of how technology is essential to the daily flow of learning. A description of the learning process provides the context for significant gains in standardized test achievement and attendance data over a three year period.

Body

The Virginia Nelson County School Division has dedicated resources to produce a systemic change in learning through technology. The commitment is pervasive throughout the five primary/elementary schools, the one middle and one secondary school. Computer utilization focuses on:

1. Pragmatic skills. In this venue, teachers and students use word processing, spreadsheets, database and telecommunications in their learning much as they utilize the phone.
2. Conceptual and aesthetic changes. The use of CD ROM and interactive software creates a learning environment using multimedia and learning based in contemporary cognitive science to resolve complex problems (R-S vs. traditional S-R).

The process of learning by using computers and the means by which they radically change instruction in a rural county not endowed by wealth, but by the professional desire of its educators, is central to the success of the county's learning community.

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Revolutionary Classroom (W3-207B)

How Computers Really Should be Used in the Science Laboratory

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Key words: secondary, science, laboratory, computer, tools

Abstract

Often computers are placed in a classroom and science teachers are told to develop one or two units that will put the students into these Rhigh tech computer labs for only a limited time. Unfortunately, such experiences give the students a false impression of how technology is used in science. This presentation will show how computers should be utilized in the science laboratory and classroom. An example unit in physics that involves the students in exploring interactions involving contact forces will be presented. How computers are used to enhance that experience will be demonstrated and illustrated. The audience will see how lab teams of 4-5 students select different computer interface devices to collect data, analyze and present the data with a data analysis/graphics application, and communicate results to other lab groups through telecommunications. They also have the option of designing and testing a model utilizing simulation software and to collect background information using interactive videodisk

Distance Learning (W3-306A)

TEAMS Distance Learning: A Model for National Reform at the Elementary Level

Rick Nupoll

Key words: TEAMS, distance learning, elementary, mathematics, science

Abstract

More than 80,000 students are participating in the TEAMS Distance Learning programs. Nationally recognized and award winning, TEAMS is a Star Schools program funded by the U.S. Department of Education (O.E.R.I.) and the Los Angeles County Office of Education (LACOE). It's a service of LACOE and is delivered from its ETN (Educational Telecommunications Network) facilities in Downey, CA. TEAMS is a cost-effective partnership reaching out to provide motivational distance learning opportunities to elementary students, teachers and parents throughout the United States and Canada.

The major focus of TEAMS is direct student instruction for grades 2-6 in mathematics and science. Programs are designed to develop a team-teaching approach between the classroom teacher and the studio instructor. The programs follow national directions in mathematics and science. Instruction is characterized by: active learning; development of mathematics and science concepts, problem solving, and critical thinking skills; development of oral & written language proficiency, in the content areas; and, motivation of students to continue in mathematics and science.

TEAMS distance learning programs reinforce and enhance subjects already taught in elementary school. TEAMS is designed for self contained classrooms, as it is simultasneous direct instruction to students and staff development for teachers. TEAMS classroom teachers are supported by additional staff development programs and receive an extensive teacher guide for each telecast. Unlike the high schoool distance learning courses, TEAMS programs are designed in instructional modules which can be integrated into the teachers' existing lesson plans. The entire classroom participantes in these instructional modules.

Society Session (W3-310A)

Information Technology: Changing The Way We Do Business (CAUSE)

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Key words: information technology, management, higher education, trends, strategic planning

Abstract

Information technology has had a significant impact on the management of higher education during the past twenty-five years. What began as a revolution to automate current processes has evolved into a transformation of our organizations and the way we do business. This session will look at the current use of information technology in higher education and some of the issues that will be important as we plan for the twenty-first century.

Society Session (W3-311A)

Proposed Model for Licensing Computer Professionals (ACM SIGCAS)

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Key words: licensing, certification, professionalism, ethics, standards

Introduction

The licenseing and certification of computing professionals is a very controversial and political question. Those opposed to licensing raise issues of freezing technology, limiting research, causing loss of jobs, and unreasonable government interference in the practice of a trade; while those in favor of licensing talk about licensing as a cure- all for the ills surrounding computing and human interaction with the products of computing. The extremes of both of these positions obfuscate the underlying issues and possibilities of licensing. The model of licensing below attempts to address many of the concerns and objections raised by the professionals on both sides of the issue.

Model for Licensing Computer Professionals

This model is based upon the establishment of national standards supported by computing professionals and implemented by state governments modeled on licensing standards similar to those for Professional Engineers and Paramedics. It would consist of:

1. *A commitment to a body of knowledge*—a 4 year degree. This will assure that practitioners will have at least come in contact with the current best practices.
2. *A commitment to continuous-education*—license expires every 5 years. A paramedic's certification expires every 2 years and he/she is re-tested on the new medical practices directly related to their specialty. The same continuous education principle should apply to the computing professional. Only using computing practices of 20 years ago does not produce the best computing system. This principle does not specify how the practitioner must acquire this knowledge. Before being re-tested the practitioner is informed of the new areas to be covered. This emphasis on re-education meets the concern that

licensing would freeze technology. Licensing would have the opposite effect; it requires that all licensed practitioners keep up with the changing technology.

3. *The skill content will be determined by computer practitioners.* The IEEE and the ACM have done this for computer science education. The US military and other countries already have skills tests for computing professionals that can be use as a guide.

4. *Different levels of licensing based on skills and areas of competence.* Paramedics, depending on their area and training, are certified to administer different levels of care to patients. Computer practitioners should only undertake tasks that they are competent to complete. This is consistent with the ACM Code of Ethics.

5. *Commitment to competence to apply the learned knowledge*—three years working with another Licensed Computer Professional. Software development is not a purely theoretical discipline. Competence is gained and shown by applying the theories one has learned. This apprenticeship requirement is similar to the CPA requirement.

6. *Commitment to follow the standards*—sanctions for violations of the best practices and violations of the code of ethics. This clearly introduces a counter-pressure to any budgetary or schedule pressures to develop a shoddy product.

Project (W3-313A)

Constructing Primary Mathematics

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Key words: mathematics, constructionist learning, primary education, school reform, teacher development, Logo

Abstract

This session will share the experience of an educational computing consultant responsible for assisting six kindergarten through second grade teachers embark on the transition from a textbook-based instructionist approach to teaching mathematics to creating a learner centered constructionist environment. With the help of a grant from the Governor of New Jersey and RJR/Nabisco each classroom was equipped with one Macintosh LC II computer and printer and a consultant was hired to spend one day each week (primarily in a computer lab) working with the teachers and their students. LogoWriter was chosen as the principal software environment to accompany the math manipulatives, games, calculators and other resources.

The microcomputer creates and environment for thinking mathematically not possible with other materials. Computing environments, such as Logo, have transformed mathematics and creates an opportunity for teachers to reinvent mathematics education as outlined by the NCTM Standards.

The computing aspect of the program began in September 1992 in the midst of formidable opposition on the part of the teacher's union. There was fear that the additional need to learn to use LogoWriter and a non-basal approach to mathematics would place an unfair burden on the teachers. By the end of the school year, the teachers involved asserted their desire to continue teaching math in a Logo-like fashion and expressed their concern that other aspects of the curriculum were not better integrated and learner centered.

This session will explore how these teachers came to love teaching in an environment in which students actively question, investigate, and solve problems and the role LogoWriter played in this transition. Examples of student work and appropriate classroom Logo activities will be shared in this presentation. Ideas for staff development, extending the project, and the use of new Logo environments, MicroWorlds and Geo-Logo will be discussed.

Project (W3-313B)

Using Interactive Mathematics Texts as Teaching Tools

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Key words: mathematics, interactive, higher education, software design

Abstract

The Interactive Mathematics Text provides a seamless learning environment wherein a student can explore mathematical ideas, computationally and graphically, as well as obtain needed background information and procedural instructions. Within the context of a particular topic, the user can pose his/her own problems, create or alter equations and functions, and actively observe their mathematical behaviors. The basic textbook can be readily created by the teacher for student use.

The author is developing an interactive laboratory manual for teaching calculus based on Project CALC (a National Science Foundation funded project at Duke University). The development tools are: Toolbook, a Windows-based, multimedia presentation software package, and MathKit, a specially-designed mathematical software. The integration of the two programs permits not only multimedia-enhanced presentation of mathematical ideas, but also user-controlled study and analysis of given data or "real time" interactively collected experimental data.

Spotlight Session (W4-BRBA)

New Networking Directions

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Key words: networks, curriculum, future, projects, home

Abstract

Technology, per se, is of little interest to schools, but when technology is integrated into the curriculum to help solve pressing educational problems, it is eagerly embraced and utilized. Just as microcomputers had marginal educational impact as long as they were divorced from the classroom and the curriculum, telecomputing will have little effect until schools embrace it by reconceptualizing the curriculum in ways that take full advantage of its potential.

Telecomputing can become a vital force for change when it supports a project-oriented, student-centered approach that is integrated into school curricula. Examples of this integration will be presented based on extensions many schools have made of the Kids Network materials and, at the high school level, in the variety of implementations of the TERC Global Lab project.

The greatest hope, however, for more effective use of technologies, can only come when students have more access to computers and networking, particularly in the home. Little work has been done on this because of the equity problems inherent in the assumption that kids have home access to computers. It will only be a few years, however, before networking reaches all homes and connects into computers that look like game machines. While the economics of home video and shopping will drive this connectivity, the opportunities for education are staggering. Homework on computers, out-of-school collaborations, and cyber-courses are only just around the corner. We need to begin now to set the policy and undertake the educational research and development these technologies demand.

Paper (W4-201A)

An IT Revolution in UK Schools?

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Key words: information technology, schools, national policy, research, impact

Abstract

Evidence indicates that the anticipated IT revolution in UK schools has not occured. Change has been patchy and inconsistent. A national research project found that IT can have a beneficial effect upon teaching and learning, but also a range of inhibitors to widespread use. Detectable impact appears to depend on a minimum threshold of IT use, teacher innovators, and an associated embedded philosophical underpinning.

Introduction

Many initiatives in various countries have attempted to foster the use of IT in schools. The UK has been no exception. Despite claims that an IT revolution has taken place, it is not easy to detect educational outcomes. The key question is "has IT influenced the nature of teaching and learning in classrooms?" This paper reports how a research project has provided some findings which enable us to have a greater understanding of the reality behind the rhetoric.

The National Scene

For over a decade the Department of Education and Science (DES) has followed a strategy to enhance the quality of teaching and learning across the curriculum through the use of IT in schools. Two national projects, the Microelectronics Education Programme (MEP 1981-6) and the Microelectronics Education Support Unit (1986-9), provided funds for software development, teacher training and an information base. The current New Information Technology for Schools programme provides grants for professional support for specialist IT advisers in Local Education Authorities (LEAs) and Teacher Training establishments. Substantial support for equipment and training has been provided also by the Department of Trade and Industry (DTI), the Department of Employment and LEAs, schools, governors and parents.

Throughout this period, the use of computers has changed. A clear justification for the expenditure from the DES and DTI was to train computer scientists and a computer literate population. In this sense the rationale behind the introduction of IT into schools was as much vocational as pedagogic (Hawkridge 1990). Richard Fothergill, director of MEP said in 1981 that the main purpose of the programme was "to prepare pupils for a world in which devices based on microelectronics were commonplace".

In the early and mid-eighties, computer science examinations and computer awareness courses flourished. There was however a growing awareness that pupils should use IT for learning their main subjects, rather than treating IT as a separate subject (Watson 1987). A national document, Information Technology 5-16 (HMI 1987), with an emphasis on IT as a vehicle for enhancing teaching and learning, laid the foundations for the style of IT to be associated with our new National Curriculum.

Until 1988, schools in the UK were not prescribed what was to be taught; they had complete autonomy over the curriculum content of their classrooms. Although public examinations, set by university boards, at 16 years and 18 years had a major unifying effect, pupils could move and find no cohesion between the curriculum in their old and new schools. While this autonomy was a breeding ground for innovative curriculum developers, the problems thus created were substantial. In particular there was no minimum entitlement in terms of curriculum base and attainment expectancy for pupils. In 1988 the government passed an Education Reform Bill which has had a major effect on all aspects of school life, from management and financing, to curriculum and assessment.

IT was placed within this National Curriculum as a specific Attainment Target with an associated Programme of Study within the Technology document, aimed at developing IT capability; but IT also appeared within the Statements of Attainment and Programmes of Study of other subjects—mathematics, science, English, history, geography, and modern foreign languages. Thus IT was to permeate all the curriculum, and not just be a separate entity. All schools were advised that they were required to appoint an IT coordinator and produce a whole school IT policy.

Thus after a decade of endeavour, IT in schools was placed firmly in two arenas, a technological capability which every adult required, and Computer Assisted Learning. While we in the CAL field laud this cross-curricular approach, IT is virtually the only subject in the NC that has been so identified. Thus it still stands outside mainstream perceptions which are now so dominated by the articulations of programmes of study of separate subjects.

Evidence of Use in Schools

The DES has carried out statistical surveys of the use of IT in schools every two years since 1986. From these useful information can be gleaned; for instance, by March 1992:

- primary schools (ages 5-11 years) had on average 7 computers, and a pupil: micro ratio of 25:1. This compares with 2.5 computers and a ratio of 67:1 in 1988;
- secondary schools (ages 11-18) had on average 58 computers and a pupil: micro ratio of 13:1. This compares with 23.2 computers and a ratio of 32:1 in 1988;
- the percentage of primary staff confident in IT use was 72% compared with 56% in 1988. In secondary schools the figures were 53% in 1992 and 48% in 1988;
- 90% of primary teachers and over 80% of secondary teachers had received basic IT awareness training. Over half of all teachers had attended more in-depth courses;
- about a third of primary schools, and a third of secondary heads of department reported that IT had made a substantial contribution to teaching and learning; about two thirds said IT had made some contribution.

On this basis, the DES tends to make statements to the effect that "the UK is a leader in the field." But counting hardware, ratios of micro per pupil and the number of training courses attended, tells us little about the actual IT use by pupils in school.

Further examination of the data reveals a worse picture. In 1992, IT's contribution to teaching and learning in secondary schools was particularly marked in business and computing studies. But the reported contribution of IT to other subjects, such as the sciences, mathematics, and geography, was considerably less. Indeed, across all subjects, only 17% reported "substantial" use was made of IT in their teaching, 30% reported "none", and the remaining 53% reported "some". Note however that "some" and "substantial" are not defined by the survey; one or two lessons a year could be reported in this category. Thus the actual curriculum use of IT by teachers is still small.

Her Majesties Inspectorate (HMI), an independent body of school inspectors, make regular curriculum reports based on detailed visits and consultations nationwide. Recent reports (1990, 1992) identified "some" interesting use of IT in nearly every subject of the curriculum, at best leading to an enhancement of study. But the secondary school report shows that, while many pupils can competently manipulate text and pictures, and some can carry out investigations using data, very few can use IT to carry out scientific experiments, and that insufficient attention is given to exploring computer models and simulations.

In general HMI's findings show that, as the need to breed confidence and familiarity with IT has diminished, and as the implications of the NC for IT in a range of subjects have begun to be felt, schools have not yet translated this into any substantive action within classrooms. These findings are unfortunately very similar to those they reported in 1986.

Research into the uses of IT in education have included studies on the effects in particular subject areas, on collaborative learning, of particular types of software on children's learning, and classroom management of IT. Some involved studies of the uses of computers in different educational contexts, for example 'Information technology and group work in physics' (Howe et al.1991), or research into the uptake of computers in schools—Cox and Rhodes (1990), Plomp and Moonen (1991). Some small studies focussed on a single curriculum area (Hoyles and Sutherland 1987, Martin and Smyth 1987) while other larger studies covered a range of concept and skill learning. Over 250 studies have been reported in the literature (Niemiec and Walburg 1992) on the effects of IT on pupils' learning of particular skills and concepts.

These research findings provide evidence of the positive effects of the use of IT on pupils' learning, for example, that pupils develop skills in writing through the use of word processors, or develop a greater understanding of mathematical concepts through the use of LOGO. However, there had not been a large scale comprehensive and longitudinal study of pupils' achievements using IT. Such a study was particularly timely in the UK and needed to address the conundrum of why, despite reported benefits and substantial investment, a real revolution in terms of the use of IT in schools was still not apparent.

Within this context, the ImpacT study was commissioned and designed.

The ImpacT Project

The Research Design

The ImpacT study, an evaluation of the Impact of Information Technology on children's achievements in primary and secondary schools, ran from 1st January 1989—31st December 1991. The work commissioned by the DES was carried out by a team of researchers in the Centre for Educational Studies, Kings College, University of London (Watson 1993). The focus of the research was on pupils' learning and classroom activity involving IT in the school age bands 8-10, 12-14, and 14-16, in the subject areas of mathematics, science, geography and English. This was the first in-depth investigation undertaken which focussed on the impact of IT across a broad age band and range of school subjects.

A large field study was designed involving over 2,300 pupils from 87 classes in 19 LEAs, distributed geographically in England and Wales. These pupils came from matched pairs of classes. These classes were nominated for their good teaching and curriculum delivery; one of each pair was also identified as making regular use of IT and so was designated HiIT, while the other was identified as LoIT. The pupils thus divided into a matrix of 12 cells; three age groups, 8-10, 12-14, and 14-16, and the four curriculum subject areas. This sample was used in a research framework that had three substantial parts.

- An assessment of pupil's achievements of specific learning tasks and skills, through the administration of specifically designed subject-focussed assessments to the matched pairs of classes in each cell. These reasoning-in -subject assessments were supplemented by topic-specific mini-studies in some pairs and also some HiIT-only classes, and a final test for IT concepts and skills. Statistical comparisons of test performance were adjusted through the use of general ability assessments.
- In-depth longitudinal case studies in a few HiIT classes were focussed on classroom processes and pupil interactions. Classrooms were observed, pupils and teachers were questioned, and documentary evidence was gathered to provide illumination on classroom realities. Qualitative analysis was based on those themes and issues that emerged from the data.
- IT resourcing and use was monitored throughout by the regular returns of questionnaires and data sheets from the teachers and pupils in each class. Hardware and software provision, pupils' IT use in ImpacT subject and across all subjects and pupils' extra-mural use were analysed descriptively by classes, age cohorts and subjects.

The Findings

The results from the three parts were integrated to address three main questions:

- Did IT make a contribution to pupils' learning?
- Does incorporating IT affect the planning and practice of teaching?
- What were the organisational demands of IT on the schools?

A Contribution to Pupils' Learning

IT did make a contribution to learning, but this was not consistent across subjects or age bands. Data supporting this was from subject reasoning assessments and topic specific mini-studies. The focus of the subject reasoning assessments was on higher order processes and thinking in each subject; for example, relational thinking in mathematics, formulating hypotheses in science, drawing inferences from map, graphical and photographic information in geography, and aspects of cohesion in pupils' writing in English.

The most dramatic results came from mathematics and geography in the 14-16 age band. There was some evidence in support of the use of IT in primary English; the case for IT in science was not supported.The overall effect for reasoning in subjects, age by subject combined, was statistically significant in favour of the HiIT group. As an indication of the relative size of the effect, this difference was in the order of an equivalent contribution of a mean success rate on a public examination of 52.8% by the HiIT group compared with 47.2% by the LoIT group.

Actually the results from a small number of the HiIT classes provided the main evidence for these findings. Access and use in these classes suggested there was a minimum threshold of IT use for the impact to be detected.

Five of the eight topic-specific mini-studies provided evidence of IT use contributing to learning; in each case the contribution was in terms of higher level processes or thinking. For example, in the mathematics mini-study on angles the two classes were studying the same materials, with the pupils in the HiIT class also working with LOGO. The HiIT class achieved significantly higher results, with the main contribution being to the application of the concepts and relationships.

The main focus of the case study research was on classroom processes. This research must be qualified in that while the data collection was rigourous and detailed, the analysis was designed to provide exemplification rather than generalisations. Selected observations suggested considerations which supported and extended results from the assessments. For example:

- computers were found to be good motivators which heightened pupils' interest and enjoyment and were also seen to have a positive effect upon the status of the subject;
- computers aided concentration by focussing pupils' attention on the work in hand and as a result some pupils and teachers believed that the standard of work produced was of a higher quality than it would have been otherwise;
- opportunities to work in an open-ended way enabled pupils to become involved in more complex and challenging learning situations beyond that typically experienced.

Some of the failures to detect any effect of IT use may be related to problems encountered in case study classes:

- difficulties in using a particular software package;
- inability to work effectively in a collaborative environment.

The case study analyses also indicated a critical element in the notion of HiIT—this was the importance of the interaction or interplay between hardware/software availability and use, and the role of classroom organisation and management and teaching styles.

The Effects on Pedagogy and Practice

The planning and practice of teachers using IT involved a consideration of classroom management and organisation, teaching styles, and hardware and software availability and use. The results from the case studies, mini-studies, and IT use indicated that the most important factor was the role of the teacher.

Careful attention to organisation and management, in particular the effective use of collaborative or group work, was important. Effective use of IT required substantial knowledge and understanding of, and familiarisation with, a variety of software in order to integrate the activity, in philosophical and pedagogical terms, with a larger scheme of work.

General purpose software, such as spreadsheets and databases, placed additional demands on the teacher, beyond that of familiarity with more complex software. These included more reflection on the nature of the subject and the potential role of such software in enhancing processes and understanding.

The Demands of IT on Schools

Even in those schools with a policy for allocation of resources and in which there was a higher than average number of computers, there were often problems with equity in access (timetabling, booking of a computer or the computer laboratory). In primary schools this was compounded by the small number available to the class at any one time, as computers were often located one per room rather than in clusters. In secondary schools this was compounded by the constraints due to demands of particular subject areas, e.g. business studies. Whilst a school policy was found to be important, this was not sufficient in itself; the use of IT was dependent upon the interest of individual teachers and/or departments.

The case studies suggested that the interest and support from Head teachers was a factor, but that this could be described as 'letting the teacher get on with it', rather than a more pro-active stand in favour of the integration and implementation of IT. The support of Head teachers was important in the acquisition of equipment and in the targeting for particular funds. It was important for the teachers to feel they were supported by the senior staff.

Concerns expressed by teachers in the IT use data and case studies indicated that many needed an on-going programme of in-service training, if they were to make regular use of computers in their teaching and exploit the potential offered by some software.

Implications of Findings for Resources and Policies

The issues raised by these findings are complex and not easily reduced to specific short term recommendations for which the research was not designed. The results do however indicate areas which need covering in any strategy for enhancing the educational opportunities for all pupils through IT.

Learning

There was a minimum threshold of IT access, experience and use necessary for the contribution to pupils' learning to be apparent. This threshold involves more than a workable pupil/computer ratio; current provision of hardware resources in most schools is not sufficient.

Not all pupils were provided with opportunities to take advantage of the potential of a full range of software. Access and time must be considered not merely in terms of in class, but also other in-school, out-of-class opportunities, through open-access learning resource areas or libraries.Software used for exploratory or enquiry focussed work provided pupils with opportunities to take decisions and make choices which promoted higher level learning outcomes. Collaborative work by pupils was an important dimension, but many pupils found it difficult to engage in this activity; they need to learn how to work effectively in such contexts.

Teachers and Pedagogy

Although some teachers made effective use of IT, there was seldom any cascade of their experience and expertise, even with highly supportive colleagues in the subject peer group. Teachers would benefit from more planned opportunities to share their experiences of using IT.

Particular pedagogic skills and understandings of teachers appeared to contribute to their effective use of IT, including their view of their subject, a balance between knowledge and process, and confidence, classroom organisation and management skills, and teaching styles.

School Resources and Policies

Individual school policies seldom included long term projections or goals consistent with the intended role technology across the school. The current level of provision and related demands from some teachers were in conflict with a distribution which was both equitable and adequate for individual teacher demands.

Most whole school policies for IT were not producing cooperative efforts across school subjects in a systematic and coordinated fashion. Nor do they provide on-going opportunities for reinforcing and extending pupils' IT capability.

In-service training should focus on the development of a philosophical underpinning, both of school subject and the potential supporting role of software, and the development of classroom organisational and management skills, and teaching styles conducive to more open-ended and collaborative work by pupils.

Conclusion

This research has shown that IT can make significant contributions to teaching and learning, but that a variety of inhibitors are still limiting the scope of impact. In particular, that:

- IT has had a positive impact on children's achievements, but this was not consistent across subjects or age-bands;
- this positive impact was difficult to separate from other such factors as pupil access and opportunity, teacher ability, and school and LEA support;
- that of the subject areas studied, the contribution of IT was especially significant in mathematics, geography and primary English;
- the results were influenced by the extent of use and integration of IT into subject teaching;
- the results pointed towards the existence of a "minimum threshold of IT use" before the impact of IT could be detected;
- the contribution of IT was in terms of increased motivation, concentration and more challenging learning situations;

- the evidence pointed to the need for an on-going programme of in-service training, covering not just hardware and software, but providing a philosophical underpinning in terms of school subjects, and teaching, organisational and classroom management skills.

Thus in spite of a number of commendable efforts and a sustained national strategy for the implementation of IT in education, people at all levels needed more help in formulating clear policies and strategies; this should go beyond focussing on particular aspects of issues and problems and provide a comprehensive and long term view to take full advantage of the potential impact of IT on pupils' learning.

This research confirms that if schools are to build successfully upon the foundations of awareness and basic skills, then they must ensure that the use of IT is led by subject considerations rather than by the impetus of enthusiasm for IT alone.

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Paper (W4-201B)

Participatory Design of Educational Software

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Abstract

This paper looks at the problem of giving public school teachers a real voice in the design of educational software. We believe that the solution will be found in the emerging field of participatory design, which seeks techniques for involving workers in the design of new technology that will change the way they do their jobs. We present a case study and describe our federally-funded research project on participatory software design with teachers.

Introduction

At a recent panel discussion about enabling users to participate in software design (Williams, Begg, Kuhn, Richardson, & Suchman, 1993) a member of the audience responded to a description of the difficulty of enabling computer-illiterate schoolteachers to participate in the design of instructional software by demanding, "What are the teachers doing about it?! What initiative are they taking?!" We believe that teachers carry a double burden — not only the all-to-common disregard of computer professionals for the users of their software, but also the all-to-common failure of the general public to acknowledge that teachers have many of the same workplace issues as other workers.

In this paper, we look at public school teachers as workers and at the public school as their workplace. We consider teachers to be the arbiters of curriculum. Thus, we view as crucial the task of learning how to give teachers, especially those who are not computer-literate, a real voice in the design or customization of the software they will use on the job — that is, in the classroom. We believe the answer to giving teachers that real voice will be found in the emerging field of participatory design.

Participatory design is devoted to involving the end users of a new technology (such as new software) in the design of that technology — especially in cases where the technology will change the way the workers do their jobs (Schuler & Namioka, 1993). The underlying philosophy of participatory design is that it is at best arrogant and at worst impossible for outsiders to predict what impact a new technology will have on someone's work and workplace. Participatory software design differs from traditional approaches to collaborative software design in that it seeks to give workers a direct voice in design, rather than to have a computer professional speak on their behalf. In particular, it seeks to secure workers' participation beginning with the earliest stages of design, well before the formative evaluation of software or prototypes developed by engineers. Researchers are studying how to involve workers as diverse as nurses (Bjerknes & Bratteteig, 1987), architects (Peng, 1992), and software engineers (Muller, 1991) in the design of new technology. Little participatory design work, other than our own, has focused on teachers (Williams, 1993; Williams & Begg, 1992; Williams & Begg, 1993a; Williams & Begg, 1993b).

Clement and Van den Besselaar took a retrospective look at participatory design projects (Clement & van den Besselaar, 1993). Their survey included projects that took place in a variety of countries and a variety of workplace settings. They observe that the five most important ingredients in a participatory design project are these: (1) workers must have access to information that is relevant to the project; (2) it must be possible for the workers to take an independent position on the problems; (3) workers must participate in the process of decision making; (4) participatory development methods must be available for use by the participants; (5) there must be organizational and technical flexibility, not an expectation that the participants will adhere strictly to a pre-determined organizational model or technology. In our experience, the third and fourth of these ingredients are the most crucial in the workplace of the public school teacher.

Workers must participate in the process of decision making. In many parts of the country, including Massachusetts, public school faculties have shrunk because of budget cuts and changing enrollments. The youngest teachers, the ones most apt to have had computer training, have been laid off. The remaining teachers, in many cases, have little or no familiarity with computers. For example, in the case study described in the next section, only two of the teachers we worked with had substantial experience using a computer, and their experience was limited to word-processing. It is as difficult in the teachers' workplace as in any other workplace to achieve true user participation in software design or customization.

Participatory development methods must be available for use by the participants. It is our opinion that the key issue here is translation between users and software developers. The translation involves not only the different terminology used by teachers and software developers, but also the understanding of each other's work and workplace. We have successfully used a former-teacher-turned-computer-scientist as the translator in our projects. The translator understands not only the language used by teachers and by software developers, but also the detailed nature of their work and conventions of their workplaces. The translator can employ participatory design techniques to make sure that there is a meeting of the minds between teachers and software developers.

For general information on participatory design, see (Muller & Kuhn, June 1993; Muller, Kuhn, & Meskill, 1992; Namioka & Schuler, 1990; Schuler & Namioka, 1993). For more information about translation in participatory design, see (Williams & Begg, 1992; Williams & Begg, 1993a; Williams & Begg, 1993b).

The next section presents a case study of the participatory design of educational software. It is followed by a discussion of the conclusions drawn from the case study and a description of our federally-funded research project for the formal study of the participatory design of educational software.

Case study

This case study concerns the introduction of new computer technology (a newspaper editorial system) into the curriculum of a public-school English department, which previously had no computer technology available in the classroom. The customization of the new software was an exercise in participatory design.

An editorial system is a hardware and software network used by reporters and editors at a newspaper. It is designed especially for creating, sharing, and editing newspaper articles. An editorial system is highly customized for writing and editing, and for collaboration between writers and editors. The newsroom staff create the content of articles, but are not responsible for the appearance of the final page. Thus, an editorial system provides basic text-formatting capabilities, such as bold and italic, and does not include a page layout facility.

The hardware and software for a 22-seat editorial system were donated by Atex Publishing Systems (Billerica, MA, USA) for this project. The editorial system has been installed in the public high school of a middle-class suburb of Boston. The school has 10 English teachers and an enrollment of 900 students in grades nine through twelve. The editorial system has been customized for teaching and learning, and is currently in its second semester of use at the high school. To our knowledge, this project is the first to customize a commercial newspaper editorial system for instructional use in the high school classroom.

The editorial system's hardware consists of 22 terminals (a mixture of Atex terminals and IBM PC's); Atex proprietary keyboards, which are highly customized for writers and have dedicated or programmable keys for many word-processing functions; a customized Digital Equipment Corporation minicomputer; and a laser printer. The software is Atex's basic editorial system, used worldwide by newspaper writers and editors. The software offers traditional word-processing capabilities, nearly all of which are available via special keys on the keyboard. It also offers features for cooperative work by writers and editors. These features include electronic mail, file sharing, and red-lining.

Each sophomore and junior English class uses the editorial system lab, instead of a traditional classroom, for one out of four terms. Thus, the lab is used by a total of 450 students per year. All of the English department's 10 teachers chose to be trained to use the editorial system.

The premise of the project is that the interaction between teachers and students in the writing classroom can mimic in may ways the interaction between editors and writers at a newspaper. However, a classroom is a different workplace from a newsroom. In particular, the flow of information in the classroom is different from the flow of information in a newsroom. In order to adapt the editor-writer model for the classroom, the editorial system needed to be customized. The types of customizations that were made are discussed below.

Participatory design of customizations to the editorial system. The teachers were experts in teaching writing, not in using computers. Understandably, none of the teachers knew enough about hardware or software to direct the customization of the editorial system or even to carry on useful dialogues with the software engineers. They had neither the skills to evaluate the existing capabilities of the editorial system nor the skills to tell the software engineers what customizations they needed. They were unfamiliar with basic computer-ese, such as "file," "directory," "username," and "electronic mail." They did not have the skills to look at differences in workflow in a paper-based vs. a computer-based classroom. Moreover, they were given no release time to learn about computers or to work on the customizations.

The engineers, on the other hand, were experienced in tailoring editorial systems for specific newspaper sites. They were knowledgeable about the editorial system and about workflow in a newsroom. They were used to newspaper jargon. (In fact, a lot of that jargon had been incorporated into the editorial system. Where a teacher would "throw away a paper" and a computer person would "delete a file," a newspaper person would "spike a story," a metaphor for the traditional metal spike on which papers to be discarded could be impaled. In the editorial system, a file is deleted by sending it to the "spike queue.") The engineers' language was a mixture of computer talk and newspaper talk, while the teachers spoke the language of writing instruction.

Having spent time in the classroom as students, the engineers had general assumptions about what teachers do, but were not aware of specific activities and conventions of the workplace. (A trivial example of their unfamiliarity with life in the high school classroom was their suggestion to use "stud" as an abbreviation for "student" in naming some computer accounts.) Their job was to perform customizations, but they had neither sufficient time nor sufficient knowledge of the teachers' workplace to lead the design of those customizations.

While the design team included both the teachers and the engineers, the design effort was lead by a university researcher who was a former English teacher turned computer scientist. This "translator" enabled the high school teachers to participate in the customization process by translating between their language and workplace conventions and those of the software engineers. The translation process had these steps: work with the teachers to develop a description of writing-related activities currently used in their paper-based classrooms, including workflow and paperflow; determine how these activities could be carried out and extended, based on the existing and potential capabilities of the editorial system; figure out the implications of the computer-based versions of these activities on information flow, security, and usability; teach the teachers, in their own language and in terms of classroom activities, about features that would extend their writing-instruction activities, in order to enable them to decide if they wanted the extensions; translate the descriptions of the activities from the language and workplace conventions of the teachers to the language and conventions of the engineers; and work with the engineers to specify the customizations to the editorial system.

The customizations fall into three categories: information flow, security, and usability. They address issues such as how to support the teaching of process writing, how to discourage plagiarism, and how to help students have easy access to the materials they need to have at hand. An example of each follows.

In a typical newsroom, there is only one current version of a "story." Either the editor has it or the writer has it. When one of them sends the story to the other, the story disappears entirely from the sender's workspace and now appears only in the recipient's workspace. Earlier versions of the story are stored in an archive and are rarely retrieved. By contrast, in an English classroom where process writing is taught, students are expected to maintain a library of the various drafts of an essay. When a student submits a draft to the teacher, the student should retain all earlier versions, as well as a copy of the current version, in his or her workspace. The versioning capabilities of the editorial system were customized to reflect these differences between the newsroom and the classroom. When a student submits a paper to the teacher electronically, a new version number is automatically assigned, and all drafts are archived in the student's own workspace.

The Atex engineers tell us that plagiarism is not a major issue within the newsroom. Consequently, the editorial system permits writers to have access to stories in each other's workspaces. In addition, old versions of stories are stored in a public archive and can be retrieved by any writer or editor. Plagiarism is, unfortunately, a concern in the writing classroom. The editorial system was customized to remove the temptation for plagiarism. A student is given access only to his or her own files and to certain public files made available by the system manager or the teacher. Moreover, the public archive of previous versions of essays was eliminated. All drafts of a student's essays are kept in the student's own workspace; students do not have access to each other's workspaces. (It is a basic feature of the editorial system that a document that is mailed from one user to another carries the creator's name with it in a system-maintained header.)

In the paper-based classroom, the teacher hands out a variety of department guidelines, such as the guidelines for acceptable manuscript form, the late work policy, and the glossary of correction symbols. Students are required to have these documents at hand during class. The on-line help facility of the editorial system was customized to include these guidelines. From the main help menu, students can go directly to any of these official department documents, thus obviating the need for each student to carry the documents to class.

We have not yet conducted a formal study of the effectiveness of the editorial system for teaching and learning writing. For now, we can report only anecdotal evidence of the success of this project. The teachers report the usual motivational value of successfully integrating computers into the curriculum, in particular that students enter the lab and get right to work rather than chatting with their classmates, that non-attending students start attending class, and that students who appear passive in the traditional classroom are actively engaged by the computers.

In addition, the teachers report that students are giving greater attention to the writing task. The teachers are besieged with questions about style, organization, and usage. Moreover, the teachers report that the comments that they embed in a student's electronic essay are taken more seriously than comments written in the margins of an essay submitted on paper. They say that students are more apt to perform the revisions that the teacher requests. A couple of the teachers had previously watched students use Apple computers, and had observed how the students were consumed by the joys of using various fonts, type sizes, and special effects for making their text look dramatic. With the editorial system, they report that the students are focused on making the writing good, not on making it gorgeous.

As with many other efforts to computerize the writing classroom, including the majority of those described in (Wresch, 1991), the editorial system is being used to carry out traditional classroom activities that have been moved from chalkboard or paper to the computer. The teachers are gradually learning to exploit the editorial system's capabilities for collaborative work, through the sharing of electronic documents and messages, the use of redlining, etc.

Discussion

Customization of software for the classroom can be labor-intensive. The process of customizing the editorial system for use in the secondary English classroom required the resources of our university, of Atex Publishing Systems, and of the public school system. Those resources continue to be brought to bear for further curriculum development, hardware and software maintenance, and system management.

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A member of the university research team served as the translator who lead the design of customizations. Atex provided engineers to install the editorial system and to perform the customizations, as well as a trainer to teach the teachers how to use the editorial system. The public school system bore the costs of site preparation, including the installation of a security system, and provided a summer workshop for revising the writing curriculum. The teachers have devoted countless hours to learning to use and to teach with the editorial system.

It is our opinion, based on comparison with another of our projects (Williams, Theriault, Stowe, & Canning, 1992), for which general-purpose hardware and software were used, that customization of special-purpose hardware and software poses different challenges. Because special-purpose commercial hardware and software, such as the editorial system, embody a way of doing work, they must be carefully tailored to the teachers' workplace and to the teachers' way of doing work.

The design team needs to include someone with the skills and resources to translate between the teachers and the engineers. The translator was vital to the customization of the editorial system, since the teachers and engineers did not have knowledge of the each other's work and workplace, and did not have sufficient resources to develop such knowledge. The translator was accepted by both teachers and engineers as somebody who spoke their language and who knew how their work responsibilities were being affected by the project. We believe that studying the contribution made by the translator will reveal additional techniques for empowering teachers to participate in software design.

Formal study of participatory design with teachers

With support from the U.S. Department of Education, we have embarked on a formal retrospective study of two of our projects that introduced new technologies into the classroom (the editorial-system-in-the-classroom project described above and the Revitalizing High School Computer Science project described in (Williams, Theriault, Stowe, & Canning, 1992). The goal of the retrospective study is to formulate a set of guidelines for the participants in future projects. These participants include not only teachers, but administrators, corporations, and university researchers, as well.

The retrospective study involves formal interviews with the teachers who participated in the projects (both those who championed the projects and those who did not); administrators at the school and school-system levels; corporate personnel who worked on the projects (including upper management, technical staff, trainers, and maintenance staff); and university personnel.

The guidelines for teachers focus on contributions that they can make to the design process without knowing a lot about computers. In our experience, teachers who are unfamiliar with computers feel inadequate for the design task, until they are guided to describe their classroom activities in their own language and in terms of their own workplace conventions. The guidelines should help teachers develop realistic expectations about their time commitments for the project. The guidelines treat teachers as the authorities on curriculum.

The guidelines for administrators focus on the ways administrators can provide support for teachers who are learning new technologies, participating in their customization, and teaching an innovative curriculum for the first time. In addition, the guidelines focus on the financial obligations that a school district can expect to incur, even with a "free" donation, and on the school district's interactions with university researchers and corporations.

The guidelines for university researchers focus on techniques for involving teachers in participatory design and on the development and management of a project of this type. They focus on the parts of the project that neither teachers nor corporate representatives may be able to do: translate between the teachers and the engineers. They also stress the importance of finding committed teachers who can champion innovative programs within their schools.

The guidelines for industry representatives focus on the obligation that must accompany a corporate donation of hardware and software. Even with the involvement of a university team, a corporation must expect to include installation, training, customization, and maintenance in their donation. Moreover, the corporation must schedule their personnel to spend time in participatory design sessions with the teachers and researchers. The guidelines explicitly address a problem that we have observed repeatedly: software engineers assume they know what goes on in a public school classroom, but they do not; as a result, they may make inappropriate design decisions.

The guidelines will be used in a new project, in which an innovative mathematics curriculum will be introduced into an inner-city school. Data will be collected both by observation during the design process and by surveying and interviewing participants after the design process. Moreover, the design documents (both those we provide and others devised during the design process) will be studied. The guidelines will be revised to reflect the lessons learned from the mathematics project, and will then be distributed to interested schools, universities, and corporations.

Summary

Participatory design is an important new approach to the development and customization of instructional software. Certainly, some teachers are capable of developing their own software and some off-the-shelf educational software can be incorporated into a given school's curriculum without customization. In our experience, many innovative uses of computers in the classroom are exceptions to these rules. For the use of computer technology in the classroom to move successfully in new directions, teachers as well as computer professionals must have a real voice in the design of that technology and in its incorporation into curriculum.

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Paper (W4-202A)

Let's not let The Number of Warthogs be 'X'

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Abstract

The issue of how to integrate information technology into the teaching/learning environment remains strongly associated with the use of the computer as a tool. While technology based tools such as Logo have been advocated for problem solvers at the elementary level, spreadsheets have a great deal of potential for use at both the junior and senior high school levels. In this presentation, alternatives to the solution of a variety of math problems, ranging from story problems to finding the roots of equations, will be explored. Although not all problems lend themselves to the use of the spreadsheet, such an approach *does* add a viable alternative to existing problem solving strategies. The greater the number of strategies available to students, the more likely it is that differences in learning style can be accommodated.

Introduction

It is now approximately fifteen years since micromputers appeared in the schools; many interesting phases have been witnessed since the inception. At first, in the 'euphoric phase', attention focussed on the issues of what type of computers to buy, how many there should be, and equality of access. Sheingold (1991) acknowledged this phase quite recently in remarking that "computer-based technology has been brought into schools during the past decade largely because the technology was seen as being important in and of itself". Attention next turned to "but what do we do with them" and in the absence of quality educational software, a widespread computer programming epidemic broke out thereby marking the 'dawn of reality' phase. Fortunately, during this period, productivity and general purpose software emerged. This eventuality marked a very significant downturn in the popularity of computer programming and gave rise to the 'exploitation phase' during which the computer could be employed as a general purpose tool by teachers and students alike. Despite the passage of time and rapid advances in information technology, the 'electronic education phase' that visionaries had predicted is still not a pervasive reality. The burning issue of how to integrate information technology into the teaching/learning environment thus remains strongly associated with the use of the computer as a tool. This presentation will describe and demonstrate a number of ways in which the spreadsheet can be exploited in the mathematics classroom and through them, examine the problem solving strategies available to students. An assumption is made that students have been introduced to spreadsheet basics.

Of Warthogs and Cockatoos

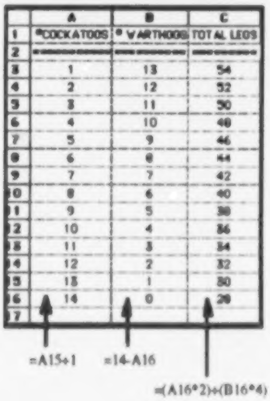
The first example presented represents the classic story problem an example of which is as follows:

> The total number of legs in a group of 14 animals is 38. The group contains only cockatoos, which have 2 legs each, and warthogs, which have 4 legs each. How many warthogs are there?

The traditional approach to solving a story problem of this type is to begin by saying "let the number of warthogs be X" then proceed to establish and solve a set of simultaneous equations. Such a rigorous, analytical strategy can be very appealing to the mathematically inclined but less so to those who are not. The less mathematically inclined might choose to make an inspired estimate of the number of animals of each animal type, determine how many legs are implied and then adjust their estmate until they zero in on the answer—the trial and error method. Both strategies are perfectly valid. The spreadsheet offers a number of middle-ground alternatives which serve to widen the spectrum of problem solving strategies available to students. Three potential strategies that students might employ in solving the warthogs and cockatoos problem are described below in order of increasing level of sophistication.

Strategy 1

One of the simplest anticipated solutions might contain three columns as shown in Figure 1. Column 'A' contains an increasing sequence of natural numbers from one to fourteen (corresponding to the potential number of cockatoos in the group of animals); the students may either enter these numbers directly or generate them using a simple formula as shown. Column 'B' contains the corresponding number of warthogs (fourteen minus the number of cockatoos); these numbers may also be entered directly or generated by a formula. Column 'C' uses a formula to calculate the total number of legs for the fourteen animals (two times the number of cockatoos plus four times the number of warthogs). While this formula could be entered into each cell, students should be expected to be familiar with the simpler concepts of copying formulas between cells.



	A	B	C
1	#COCKATOOS	# WARTHOGS	TOTAL LEGS
2	----------	----------	----------
3	1	13	54
4	2	12	52
5	3	11	50
6	4	10	48
7	5	9	46
8	6	8	44
9	7	7	42
10	8	6	40
11	9	5	38
12	10	4	36
13	11	3	34
14	12	2	32
15	13	1	30
16	14	0	28
17			

=A15+1
=14-A16
=(A16*2)+(B16*4)

Figure 1.
Warthogs and cockatoos—strategy 1

The answer to the problem is obtained by scanning down column 'B' to locate the cell where the total number of legs is 38 (row 11 in this example); the answer to the problem is then derived from the corresponding cell in columns 'A' i.e. there are 5 warthogs.

Strategy 2

The solution shown in Figure 2 reflects an entirely different way of thinking about the same problem. As with solution 1, column 'A' is filled with the natural numbers from one to fourteen to represent the number of animals. In column 'B', each animal is given two legs because each animal type represented in the group has at least two legs (thereby accounting for the first 28 legs). This column can be filled manually or using a simple incrementing formula. The "leftover legs" are next allocated two at a time in column 'C' thereby "creating" the four legged animals. Cell 'C17' contains a formula which calculates and displays the running total of the legs allocated. When this total equals thirty eight, one simply counts the number of animals which have an extra pair of legs—this will be the animal number read from column 'A' corresponding to the last entry in column 'C'.

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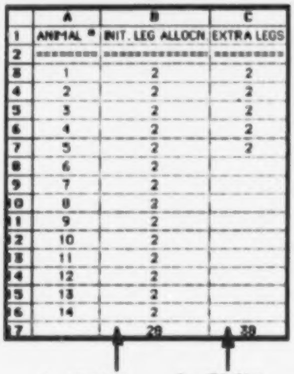


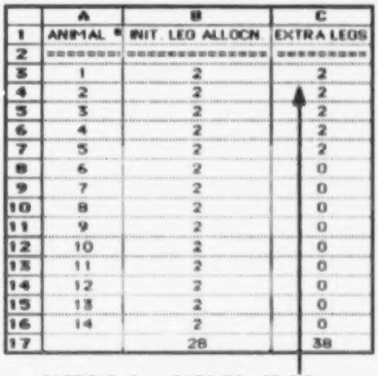
	A	B	C
1	ANIMAL #	INIT. LEG ALLOCN	EXTRA LEGS
2	========	==============	=========
3	1	2	2
4	2	2	2
5	3	2	2
6	4	2	2
7	5	2	2
8	6	2	
9	7	2	
10	8	2	
11	9	2	
12	10	2	
13	11	2	
14	12	2	
15	13	2	
16	14	2	
17		28	38

=Sum(B3:B16) =Sum(B3:C16)

Figure 2.
Warthogs and cockatoos—strategy 2

Strategy 3

The solution shown in Figure 3 is an automated version of solution 2 and is presented here to illustrate the potential variety of student approaches which might be anticipated. Column 'A' and column 'B' are filled in one of the ways described previously. The first entry in column 'C' contains the number "2". Cells 'C4' to 'C16' contain a formula which automatically allocates an extra pair of legs to the animals until all 38 legs have been assigned. The answer is read in the same manner as for solution 2.



	A	B	C
1	ANIMAL #	INIT. LEG ALLOCN	EXTRA LEGS
2	========	==============	=========
3	1	2	2
4	2	2	2
5	3	2	2
6	4	2	2
7	5	2	2
8	6	2	0
9	7	2	0
10	8	2	0
11	9	2	0
12	10	2	0
13	11	2	0
14	12	2	0
15	13	2	0
16	14	2	0
17		28	38

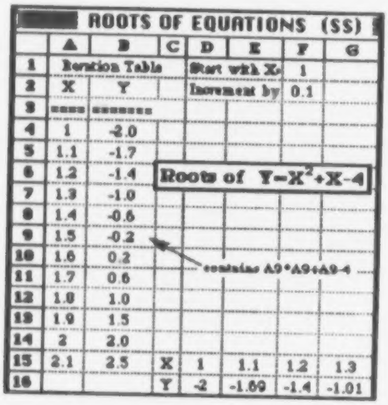
=If($B$17+Sum($C$3:C3)<38,2,0)

Figure 3.
Warthogs and cockatoos—strategy 3

This third solution is the most sophisticated of the three that have been presented. This solution entails the use of absolute cell references and the "logical if" function—it clearly requires a higher level of proficiency with the spreadsheet.

Finding the Roots of Equations

In mathematics, students are taught a variety of methods of "solving" (or finding the roots of) equations ranging from factoring to synthetic division to graphical analysis. Very often, however, equations do not have "nice roots" thereby lessening the convenience of algorithmic methods. In these instances, a simple spreadsheet (with or without plotting capability) can provide the learner with a viable tool for exploring the roots of equations by iteration. Figure 4 shows how this can be accomplished for a particular quadratic equation. As well, the approach described can provide the teacher with a very useful demonstration tool which allows for relatively quick and easy simulations.



ROOTS OF EQUATIONS (SS)

	A	B	C	D	E	F	G
1	Iteration Table			Start with X=		1	
2	X	Y		Increment by		0.1	
3	====	=======					
4	1	-2.0					
5	1.1	-1.7					
6	1.2	-1.4					
7	1.3	-1.0					
8	1.4	-0.6					
9	1.5	-0.2					
10	1.6	0.2					
11	1.7	0.6					
12	1.8	1.0					
13	1.9	1.5					
14	2	2.0					
15	2.1	2.5	X	1	1.1	1.2	1.3
16			Y	-2	-1.69	-1.4	-1.01

Roots of $Y=X^2+X-4$

contains A9*A9+A9-4

Figure 4.
Using a spreadsheet to estimate the roots of an equation

Using the graphical capability of the spreadsheet to plot the first iteration yields the graph shown in Figure 5. It is clear from the iteration table and reinforced by the graph that one root lies between "1" and "2" and the other lies between "-2" and "-3".

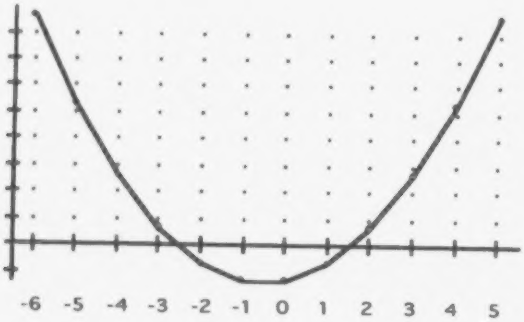


Figure 5.
Graph of $Y=X^2+X-4$, first iteration

From the graph of the first iteration, one of the roots is estimated to be x=1.5. If this root is required to further precision, a finer iteration can be carried out. The graph of such an iteration is shown in Figure 6—the start point and increment have been adjusted to zero in on the root.

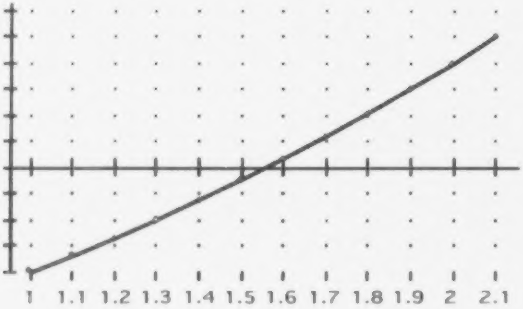
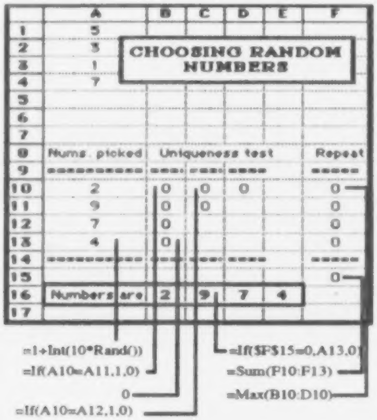


Figure 6.
Graph of $Y=X^2+X-4$, second iteration

From the second iteration, this root can now be estimated to two decimal places (x=1.56).

Towards Winning the State Lottery

This example, which is more broadly based than the previous two, has been descibed by Wright (1993). A student's desire to be successful in games of chance could be exploited to evoke an interest in random numbers. A general problem which might be assigned would be to develop an automated method of picking four natural numbers between one and ten. This problem, which lends itself well to a spreadsheet-based solution, can be approached with varying degrees of sophistication according to the extent to which the solutions address the question of repeated number selection. Figure 7 shows two potential solutions.



	A	B	C	D	E	F
1	5					
2	3	CHOOSING RANDOM NUMBERS				
3	1					
4	7					
5						
6						
7						
8	Nums. picked	Uniqueness test				Repeat
9	==========	====	====	====		=====
10	2	0	0	0		0
11	9	0	0			0
12	7	0				0
13	4	0				0
14	==========	====	====	====		=====
15						0
16	Numbers are	2	9	7	4	
17						

```
=1+Int(10*Rand())
=If(A10=A11,1,0)
0
=If(A10=A12,1,0)
=If($F$15=0,A13,0)
=Sum(F10:F13)
=Max(B10:D10)
```

Figure 7.
Choosing four natural numbers between one and ten

The simpler of the two solutions is in cells 'A'1 to 'A4'. All this solution does is to employ the spreadsheet's random number generator to pick a number between one and ten—the prospect of selecting repeated numbers is not dealt with at all. The more sophisticated solution (in the block of cells 'A8' to 'G16') also does not avoid the selection of repeated numbers but it *does* check for their presence and will not print the selection in the dark-bordered box unless the four numbers *are* unique. Students may come up with one of many minor variations on the more sophisticated of the two solutions. An even more sophisticated solution might employ the use of macros to deal with repeated number selection.

Discussion

This paper has described three diverse problem solving contexts within which the spreadsheet might be employed to considerable advantage—many others could have been presented. It could be argued that the degree of spreadsheet competency required in the case of strategy 3 for the warthogs and cockatoos problem supplants the complexity of the traditional, analytical approach. It could be argued, however, that the spreadsheet approach offers two benefits, notably; that it is more visual (less abstract) and therefore easier to relate to, and that it reflects an appropriate use of technology in an information technology age.

In the "roots of equations" example, the spreadsheet can also be employed to great advantage by the teacher to demonstrate various properties of equations. In so doing, the teacher is provided with a valuable opportunity to role model the effective use of information technology (Wright, 1993).

While technology based tools such as Logo have been advocated for problem solvers at the elementary level (e.g.Maddux, 1989), spreadsheets have a great deal of potential for use at both the junior and senior high school levels Alhough not all problems will lend themselves to the use of the spreadsheet, such an approach *does* add a viable alternative to existing problem solving strategies. The greater the number of strategies available, the more likely it is that differences in learning style can be accommodated.

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Paper (W4-202B)

A Software Laboratory Environment for Computer-based Problem Solving

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Key words: computer literacy, computer science, simulations, problem-solving

Abstract

This paper describes an NSF sponsored project to develop computer-based laboratory experiences for "hands-on" introductions to many of the major topics appropriate for an overview of computer science. Our underlying strategy is to develop structured laboratory environments that are designed to present abstract concepts through the use of computer-based simulations. These simulations will allow students to explore meaningful, but domain limited, problems that are representative of real problems solved by computer scientists and computer engineers.

Introduction

The current student profile in our "computer literacy" course (CS100) is quite heterogeneous. About 40-50% of the students are computer science majors, while the remainder are drawn from programs throughout the University. Typically, 30-40% of the students in CS100 are women, while approximately 25% of the class is composed of ethnic minorities (predominately African American). These students represent a wide range of interests and abilities. Most have little or no background in college-level mathematics.

In the spring of 1992 we began an effort to adapt this introductory computer science course to a breadth-first approach. The goal of this approach is to give students an overview of the entire computing milieu. The challenge is to develop a course that is rigorous enough to prepare the computer science majors for the follow-on courses, yet, at the same time, be both meaningful and accessible to the large number of non-computer science majors who take the course.

There are several good textbooks available that present the major aspects of computing such as computer architecture, operating systems, algorithm development, programming language paradigms, databases, and networks. However, most texts lack an integrated laboratory component. To overcome this deficiency we have embarked on a National Science Foundation funded project (DUE 9254317) to develop a laboratory environment for a breadth-first computer science overview course. This environment is composed of a collection of software modules, collectively known as "Watson." We chose the name Watson to emphasize that the environment is to act as an assistant that helps the student explore various aspects of computing.

In the past, we attempted to have students complete small assignments using off-the-shelf software in an open lab environment. We found that our open laboratories, which are successful for more advanced computer science courses, did not work well for CS100. The students were overwhelmed by the syntactic details of the various software tools they were expected to use and many students ended up very frustrated. It does not have to be this way. With the proper hardware and software, students can be presented with a positive learning experience that increases their understanding of, and appreciation for, computing.

Background

Watson is designed to support a breadth first approach to computer science. Serious discussion of this approach started with the Denning committee report [Denning, et. al., 1989] that describes a three course sequence for a breadth-first introduction to computer science. This report was the starting point for the development of Curricula 91 [Tucker, et. al., 1991] that described the core areas of an undergraduate computer science curriculum as a set of knowledge units within ten major topic areas. Exposure of students to the breadth of computing is a philosophy pervasive in these efforts and in our laboratories. We have also adopted a philosophy of closed lab sessions and provisions for group work, as recommended by the Curricula 91 report.

The breadth-first approach has influenced courses and textbooks for computer literacy. *Computer Science: An Overview*, by Glenn Brookshear [4th. Ed., 1994], is an excellent text aimed at the same student audience as our laboratories. We are currently using this text in our CS100 course. It avoids the syntactic complexities of any particular programming language or software package and, instead, focuses on the "bigger issues." However, Brookshear's text lacks an integrated laboratory component. Another text, *The Analytic Engine*, by Rick Decker and Stuart Hirshfield, comes the closest to our project since it contains an integrated laboratory environment. They state that "students are both relieved that the course de-emphasizes programming and are interested to find out that there is more to computer science." [Decker, 1990, p. 235]. Another interesting approach is provided by Alan Biermann in his text *Great Ideas in Computer Science: A Gentle Introduction* [1990]. These types of changes to computer literacy instruction are discussed in an excellent paper, "The New Generation of Computer Literacy," by Paul Myers [1989].

A recent report, *America's Academic Future*, issued by the National Science Foundation [NSF, 1992], identifies many of the larger issues facing American education. One of the primary recommendations is to "Encourage the development of discovery-oriented learning environments and technology-based instruction at all educational levels." [p. 4] There is a particular emphasis on the use of "new communication, information, and visualization technologies." We strongly believe the goals and objectives of our project are in concert with these recommendations.

The Laboratory Environment

While it would be tempting to simply search the Internet for public domain packages that cover the topics of interest, we believe that such an approach would be doomed to failure with freshman-level students. At this level, syntax and "look and feel" issues are major hurdles. A freshman student presented with many unrelated environments would spend the majority of the semester just learning how to use the software environments, rather than actually solving problems with them. It is clear that a single, consistent, flexible software environment, specifically designed to support computer-based problem solving, is needed.

Our laboratory modules incorporate a number of guidelines we have developed based on our experiences introducing freshmen to computer science. These guidelines include:

- Present a uniform environment that minimizes the need for keyboard input and prevents the introduction of syntax errors.

- Provide a consistent help system that includes information on how to use the environment, as well as high-level problem solving assistance.
- Allow for both "tutorial" and "guided discovery" laboratory experiences.
- Allow for flexibility and ease of modification.

In addition, as a practical matter, the software must be able to run on a variety of computer platforms such as PCs and UNIX workstations.

We have observed that many CS100 students feel uncomfortable in front of a keyboard. The mechanics of typing and entering commands and correcting mistakes are difficult for some. A more widely recognized problem is the difficulty students have with programming language syntax. Our approach to these problems is to use syntax directed editors so that only syntactically correct "programs" can be entered, and to limit keyboard input wherever practical.

The help system in each of the laboratory modules has been designed to provide two types of assistance: information about the software laboratory environment, and problem solving assistance. To invoke the first type of help the student presses a button marked "What is?" and then clicks on the item for which help is to be provided. A popup window appears with a description of that item. The second type of help involves problem solving advice. Initially, when laboratory exercises are written, the faculty members authoring those exercises provide a collection of helpful hints to avoid common pitfalls. This advice is incorporated into the software and displayed whenever the student indicates their need for assistance.

In order for Watson to gain the widest possible acceptance, we do not want to limit it to any one pedagogical style. Instead, our goal is to build enough flexibility into the software so that it can be used with a range of pedagogical techniques from fully scripted tutorials to directed discovery. Flexibility is also important in another sense. It should be possible for instructors who use this software to adapt it to their own style with as little pain as possible. For these reasons, our software is organized into three distinct "levels". The first level, the "message level," is a keyed text file. The existence of this level allows instructors with limited programming ability to quickly change certain aspects of a laboratory exercise, such as the definition of terms, or explanation of a problem. The second level, the "activity level", is a C source program that incorporates a number of specialized functions that allow this level to sense and control activities at the underlying level. Instructors with a working knowledge of C programming should be able to change most aspects of a laboratory exercise without needing to learn the details of the underlying software environment. The final level is the "laboratory environment level" which actually defines all of the software objects that make up a laboratory environment.

A final requirement, that we established early on, was that all software developed under this project must run on a variety of hardware platforms, especially UNIX workstations and Windows-based PCs. The ability to run on Macintosh computers was also considered important. To meet these requirements, we selected SUIT, the Simple User Interface Toolkit [Conway, 1992]. This product, developed at the University of Virginia, provides a flexible, easy to use, extensible environment that allowed for rapid prototyping of the user interface and provided for cross platform compatibility. SUIT is currently available under X-windows, Microsoft Windows, DOS, and Mac OS, and is free of charge for academic projects.

Description of the Laboratory Activities

We are using our first year funding to develop eight laboratories. We describe two laboratories in detail below and provide a brief description of the others. Each lab has two levels of presentation: a concrete, hands-on component where students manipulate objects and observe results and an abstract level where the underlying theory can be used to produce the same results.

Spreadsheet Laboratory

This simplified spreadsheet program allows students to enter arrays of data and to calculate additional data based on existing data. Sample calculations are summation, average, and projection of values based on specified growth rates. Unlike a real spreadsheet package, this environment is tightly constrained and monitored. If the student starts going far astray in completing an activity, the system provides interactive help to get him or her back on track. The concrete level is the data as it appears in the table and that can be manipulated through mouse input. The abstract level includes the mathematical equations that define the relationships between data values.

Relational Database Laboratory

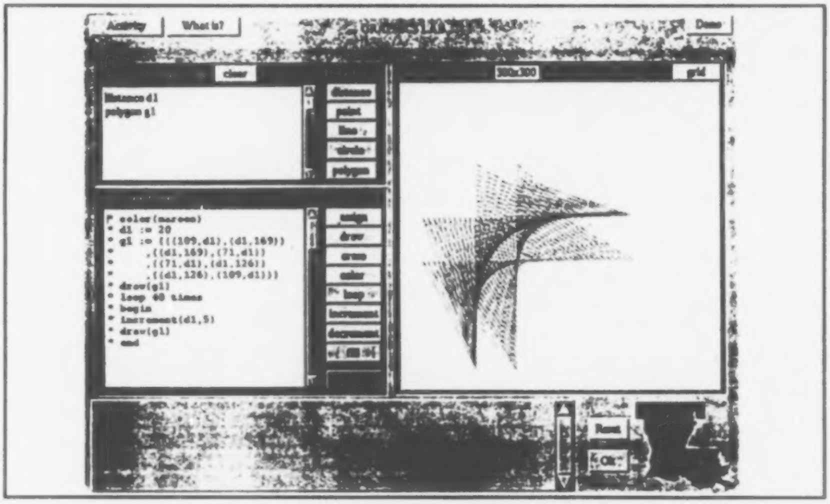
The main activities in this lab involve composing queries to answer specific questions concerning one or more tables of data. An initial academic database is provided with three tables: a student information table, a table of classes attended, and a faculty table that includes classes taught. The data has been simplified so that the student can focus on the primary activity: database queries. Queries involve one or more tables and use of the operations project, select and join. There are two modes of operation: query by example (the concrete level) and query by relational equation (the abstract level). With query by example selecting a column headings is equivalent to a project operation, matching two column headings from two tables is a join, and applying restrictions to values is a selection. As these concrete actions take place, the corresponding relational equations appear on the screen. During the second part of the assignment the student has to enter relational equations directly to obtain the desired results.

Data Structures Laboratory

The data structures lab is intended to familiarize students with the behavior of common data structures, such as stacks, queues, and trees. For example, a stack data structure is presented on the screen as a graphical object that may be activated by clicking on buttons such as "push" or "pop," the concrete level of operation. At the same time, a sequence of instructions is displayed. At the abstract level the student must solve a problem by entering a correct list of instructions and executing them. A sample task might be creating the reverse of a given stack.

Graphics Laboratory

The graphics laboratory introduces students to several fundamental concepts in computer science: declaration of object types, assignment of values to objects, and interactive manipulation of objects. A complete screen layout appears in Figure 1. The upper left window contains variable declarations, where choices such as point, line, circle or polygon are selected from a menu of push buttons. Objects must be declared before they are assigned values in the program code window. Commands such as draw and color produce changes in the drawing window. The bottom tutor window can display a description of the problem to be solved or provide assistance when errors in the student's code are detected.



distance d1
polygon g1

```
P color(maroon)
* d1 := 20
* g1 := [((109,d1),(d1,169))
*        ,((d1,169),(71,d1))
*        ,((71,d1),(d1,126))
*        ,((d1,126),(109,d1))]
* draw(g1)
* loop 40 times
* begin
* increment(d1,5)
* draw(g1)
* end
```

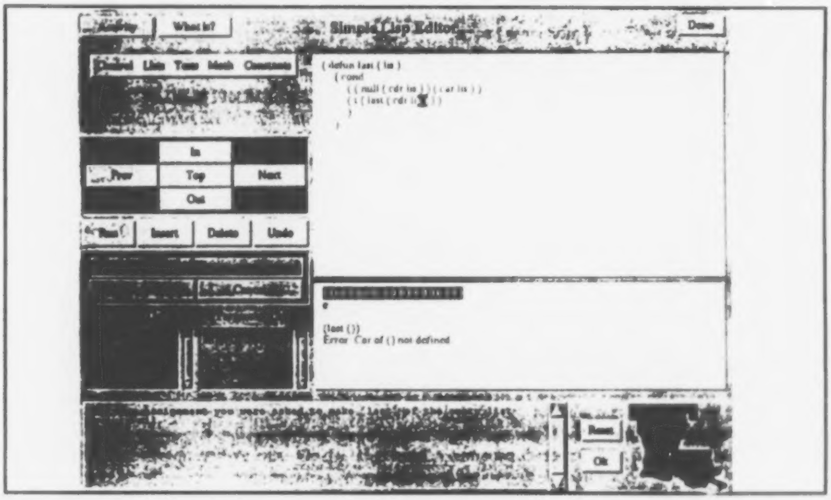
Figure 1. Screen Layout for the Graphics Activity

There is a duality between the program declarations and code (the abstract level), shown in the left windows, and the picture constructed in the drawing window (the concrete level). The student can "paint" a picture in the drawing window and watch the corresponding declarations and commands appear in the left windows, or the student can enter declarations and commands to cause a picture to be drawn in the right window. Students should be able to draw simple pictures using either approach.

The Imperative, Functional, and Logical Programming Paradigms

All three programming paradigms use syntax directed editors designed to allow students to enter syntactically correct programs and to minimize the use of keyboard input. Programming assignments are very short since the goal is not to teach the student to program well in any one language, rather it is to expose students to a variety of programming paradigms. The semantics of a program can be defined by its input/output behavior; we consider this the abstraction of the program. The actual implementation in a particular paradigm or using a particular technique (e.g., iteration versus recursion) represents the concrete level of understanding.

The imperative programming language is subset of a Pascal-like language with type declarations and commands for selection, iteration, and procedure invocation. Procedures with or without parameters can be declared. All entry is via an editor that insures the syntax and static semantics of the program are correct. Laboratory assignments do not involve lengthy programs, rather most focus on a few very small procedures designed to work together to accomplish a particular task.



```
( defun last ( lis )
   ( cond
      ( ( null ( cdr lis ) ) ( car lis ) )
      ( t ( last ( cdr lis ) ) )
   )
)
```

```
(last ())
Error: Car of () not defined
```

Figure 2. The Syntax Directed Editor for Lisp

We use the Lisp editor, as pictured in Figure 2, to illustrate a syntax directed editor; the other editors are of similar design. The following pull down menus are available: Control (defun, cond), Lists (car, cdr, cons, list, append), Tests (eq, null, atom, listp, zerop), Math (+, -, *, /), and Constants (t, nil, quote, (<list>)). A function that is defined for the first time is normally entered in a top down manner by selecting a defun option, naming the function, specifying the parameter list and specifying the function body. Once the function name and parameters are specified, these names appear in the windows called "Function List" and "Parameter List". From this point on, references to function names and parameters are through selection, not keyboard entry.

Lab activities involve writing simple functions that may manipulate lists, such as the "last" function shown, or perform simple arithmetic operations, such as a factorial function. We do not allow any setq operations and we depend on recursion to perform repetition. The intent of this lab is to expose students to the "look and feel" of a functional programming language.

The logic programming laboratory will use a syntax directed editor for a subset of Prolog that is similar to the one described above for Lisp. Logic programming is introduced from a relational perspective, similar to the academic database used in the Relational Database Laboratory. Next the list manipulation facilities of Prolog are introduced. Some of the simpler functional programming activities are replicated for Prolog.

Digital Logic Laboratory

This laboratory covers two topics: combinatorial logic and sequential logic. The concrete level of operation are the gates and flip-flops used to build circuits; the abstract level is the Boolean equation that represents the behavior of the circuit (or the timing diagram for a sequential circuit). Students first build simple combinatorial circuits using AND, OR and NOT gates. The lab environment allows circuits to be named and then recalled as "black box" devices. For example, gates are used to build a half-adder which is stored in a user defined library. The half-adder is used to build a full-adder, which in turn can be used to build a four bit adder. A major goal of this lab is to be able to write a Boolean equation for any connection in the circuit or, given a Boolean equation, build the corresponding circuit. In the final combinatorial logic activity the student builds a latch in the form of a D flip-flop and then adds a clock signal to obtain the familiar edge-triggered D flip-flop. Shift registers, counters, ring counters, and parallel-to-serial converters are studied. Students are introduced to the use of timing diagrams to analyze sequential circuits.

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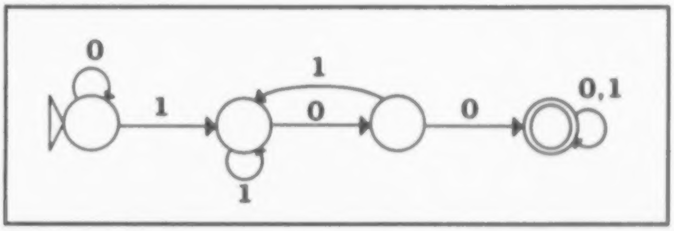
Possible Laboratories for Future Development

We hope to develop additional laboratories to cover a broader range of topics. This would allow an instructor to pick and choose topics to meet the needs of a particular target audience. For example, a computer literacy course targeted for business or education majors may elect to cover the applications and programming language paradigms, but might not cover the hardware and theory oriented components. On the other hand, a computer literacy course for engineers may elect to de-emphasize the business components and include all the hardware-oriented components. Here we only briefly describe three of the laboratories that are candidates for future development and list some others.

Finite State Automata Laboratory

Students would work in a graphical environment where they can construct and test simple finite state automata. An example challenge might be: design an FSA to accept a string of 0's and 1's if the pattern 100 appears anywhere in the string. A sample solution appears below.



Automatic Theorem Proving Laboratory

Automatic theorem proving is first introduced with the logic programming laboratory. This lab focuses on two main topics: translation from English to first order predicate calculus to clausal form and then mechanically constructing a resolution proof. Although this topic may appear to be beyond a typical student in a computer literacy class, we have had some success in the past given a well designed lab activity to introduce resolution theorem proving [Gasser, 1992].

Machine Organization and Assembly Language

We will devise a simple assembly language whose execution can be simulated with a "model" computer. This model will contain the instruction register, decoding logic, program counter, RAM memory, arithmetic-logic unit, and register set. Students will be able to enter assembly language programs and execute them, step-by-step. In this way students will learn about op codes, addressing modes, and data manipulation for a simple computer.

Other topics we may develop labs for are:

- Artificial Intelligence Laboratory
- Software Engineering Laboratory
- Programming Language Translation Laboratory
- Operating Systems Laboratory
- Distributed and Parallel Processing Laboratory
- Ethics and Computing

In addition to constructing more laboratory modules, we plan to extend the work described in this paper in a number of directions. One direction we wish to explore is the use of multimedia, including digitized voice and video. We are also interested in innovative input techniques such as speech recognition and pen-based input.

Assessment, Evaluation and Availability of Materials

We intend to insure that the laboratory experiences are useful from a pedagogical standpoint, by following a rigorous evaluation program. We are conducting our formative evaluation using the following approaches:

- the teaching is being monitored by laboratory developers who have not been assigned as the instructor
- examination results are scrutinized to indicate laboratory strengths and weaknesses

- the laboratory sessions are monitored by graduate students who report on general use of the laboratory software
- laboratory sessions are monitored electronically by keeping a history of activities for each student
- students are asked to evaluate the course content and laboratories using instruments specifically designed to evaluate these course materials
- students complete the standard evaluation forms

We plan to use pre and post tests to measure the changes in, and generalization of, problem solving abilities. Standardized instruments for measuring student attitudes will also used.

Once the laboratories are fully developed and refined at Louisiana Tech University, we plan to make them available over the Internet using ftp. We have initially targeted two platforms: Sun Sparcstations and IBM PCs. Almost any Sparcstation with a color monitor can be used. The IBM PCs require Windows 3.0 or higher and SVGA graphics support.

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Project (W4-203A)

A Spotlight on Innovative Uses of Education Technology in Louisiana

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Key words: technology, Louisiana, telecommunications, multimedia

Abstract

Momentum is growing for education reforms that include innovative uses of education technology. While excitement for computers and other multimedia presentation tools is widespread, translating this enthusiasm into a viable curriculum is not an easy matter. Without some source of guidance or coordination, educators may become lost in the flood of new products and software, or spend their time duplicating the efforts of others.

A recent BellSouth Foundation grant to the University of Southwestern Louisiana is in part to aide those wishing to integrate new technologies into classrooms in Louisiana. Through the Center for Telecommunications Studies and the Educational Technology Review Center, a database is being assembled as an ongoing project to provide information and encourage networking among Louisiana's computer using educators.

As an outgrowth of the BellSouth project, this presentation will utilize multimedia to convey the scope of education technology programs in Louisiana's K-12 schools. Video, audio, and annimated maps and charts will be accessed through a *HyperCard* control stack. The presentation will serve as both an overview of developments in the state, and an intimate look at some of the key players. Teachers and students will be highlighted in video clips, reporting on their solutions to challenges which have arrisen in using technology in the classroom.

The design of this multimedia project is such that it will lend itself to presentation to a group as well as to use by an individual. The stack will feature multiple levels of information, branching into different areas of interest and increasing detail. A self-directed user could explore his or her own interests, while a presenter in a group setting could tailor information to fit the audience. Flexibility, combined with dynamic visuals and sound, ensures that multimedia will be a part of the "revolution" in education and information technology.

Project (W4-203B)

Using Digital Captioning to Improve Literacy in Multimedia Environments

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Key words: digital video, captioning, literacy, multimedia

Abstract

This presentation will focus on the use of digital captioning to improve literacy in multimedia environments. Captioning, originally designed for foreign films and for deaf and hard-of-hearing people, is the process of providing a synchronized written text to accompany audio or audio-visual presentations. Many studies have shown that this process provides essential accessibility to deaf and hard-of-hearing individuals, as well as helping in improving literacy in hearing developmental readers, individuals with learning disabilities, and people learning English as a second language (e.g., King & Quigley, 1985; National Captioning Institute, 1991).

Digital Captioning Tools

Individuals with extensive programming skills can use a variety of multimedia programs (e.g., *HyperCard*, Toolbook, Linkway Live!, Premiere) to synchronize captions with different types of computer-controlled media (e.g., laserdiscs, digital video, CD-Audio, digital audio). However, recognizing the need for easy-to-use captioning tools, the two authors of this paper have been enhancing a program originally developed by the second author for captioning laserdiscs in Asymetrix's Toolbook. The captioning tool, called CAP-Media LD, along with a similar tool called CD TimeLiner (for CD-Audio) will be demonstrated during the NECC presentation.

Instructional Uses of Captioning

Research has shown that exposure to captioning can increase vocabulary and incidental learning (e.g., Koskinen, Wilson, Gambrell, & Neuman, 1993). Thus, the most basic application of captioning in the classroom is simply using captioned media in instructional environments.

Active learning activities with captioning are also possible. For example, using CAP-Media LD, hearing students can caption foreign movies by providing English translations to accompany the video, and deaf students can provide English translations for video involving American Sign Language. Beyond simple translations, of course, another use involves annotating the video or audio (e.g., describing the action or video; describing the intent of the speaker or the musical instruments used to produce music). Such uses provide a rich variety of activities for students and teachers alike.

Within a hypermedia environment such as Toolbook, it is also possible to do interactive captioning, whereby links between the captions and multimedia glossaries are established. Such glossaries and the capacity for creating links to digital captioning are included in an easy-to-use interface for Toolbook called Express Author (which was developed at the Institute for Academic Technology). These glossaries, which can be easily created and edited by teachers and students, allow for the full range of media elements to be linked to specific words or phrases, along with a built-in capacity for cross referencing within the glossary.

The presentation at the NECC will include demonstrations of the programs mentioned in this abstract, along with a handout describing how these tools have been used in actual classrooms.

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Project (W4-204B)

A Cross Platform CD-ROM Database for Science Teachers

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Key words: CD-ROM, physics, teachers, database, Windows, Macintosh, cross-platform

Abstract

The Physics InfoMall is a database of about 300 megabytes of information for the physics and physical science teachers. This CD-ROM contains over 4600 documents such as textbooks, laboratory manuals, problem sets, teaching hints, and student study guides. Software has been developed to help teachers who do not have a strong background in physics find information on the CD-ROM. The software, which is based on a commercial search engine, looks and operates almost identically on Windows and Macintosh computers. Development of the cross-platform software and collection of the material for the database have been the major components in the process of creating the InfoMall.

Discussion

A wealth of information exists for the teaching of any subject. Over a long period of years curriculum materials have been developed, textbooks written, reference materials created, and teaching methods described. Experienced teachers in any field collect these materials over the years and create personal libraries which provide them with the background information to teach concepts in the discipline.

A new teacher may not have access to a large fraction of this material because it has gone out of print or has limited availability. In addition, many teachers are now finding that they are teaching in areas for which they were not originally prepared. Thus, while these cross-over teachers may have a library of materials for the subject which they are prepared to teach, they may not have equivalent materials in a new topic which they have been suddenly assigned to teach. A large database with appropriate search software could help fill the gap for both the new and the cross-over teacher.

The *Physics InfoMall*, a 300 megabyte database, which is being developed to provide such a library for teachers of physics and physical science, is available on CD-ROM and contains a large variety of teaching and reference materials. By creating special software, we are developing a package which can be used by new or inexperienced physics teachers. In addition, we are creating several utility packages which can also help teachers. Thus, the *Physics InfoMall* is a large database and utility package which provides a library of materials for new or crossover physics teachers and supplements the materials which an experienced physics teacher may have collected.

Conclusions

Creating the *Physics InfoMall* has been and continues to be an adventure in the development of software and creation of large textual databases. However, based on the feedback we have received from our field testers it seems to be a valuable addition to the resources for the physics teaching community. Overall, most field testers find the materials to be extremely valuable and relatively easy to find. Further, our experiences with both the collection of materials and the development of cross-platform tools should provide useful information for anyone else who is attempting a similar project.

Acknowledgements

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The following registered trade names or trademarks are used in this document.

- Physics InfoMall: Physics Education Group, Kansas State University
- KRSWin, KRSMac, Knowledge Retrieval System: Knowledge Set, Inc.
- Macintosh, MPW C++: Apple Computer, Inc.
- MS-DOS, Windows: Microsoft, Inc.
- XVT: XVT Software, Inc.
- Borland C++: Borland International.

Project (W4-204B)

MicroObservatory

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Key words: telescopes, image processing, student research, networking

Abstract

A group of scientists, engineers and educators based at the Harvard-Smithsonian Center for Astrophysics (CfA) has developed a prototype of a small, inexpensive and fully integrated automated astronomical telescope and image processing system. The project team (which includes Principal Investigator O. Gingerich, along with R. Kimberk, S. Leiker, P. Antonucci F. Deutsch, J. Freeman and P. Kharchenko, all of the CfA) is now building five second generation instruments. The MicroObservatory has been designed to be used for classroom instruction by teachers as well as for original scientific research projects by students. Probably in no other area of frontier science is it possible for a broad spectrum of students (not just the gifted) to have access to state-of-the-art technologies that would allow for original research. The

MicroObservatory combines the imaging power of a cooled CCD, with a self contained and weatherized reflecting optical telescope and mount. A microcomputer points the telescope and processes the captured images. The MicroObservatory has also been designed to be used as a valuable new capture and display device for real time astronomical imaging in planetariums and science museums. When the new instruments are completed in the next few months, they will be tried with high school students and teachers, as well as with museum groups.

In this Project presentation we will display the telescope, show the kinds of images acquired and discuss the response to date to the telescope by students and teachers. Overall, the project is guided by the idea of using the power of newly available technologies in student initiated research. Therefore, we wish to stimulate discussion about students as research investigators. Since we also intend to develop the capability for remote access to these telescopes, networking, collaborative research and specific research techniques such as computer enhanced image processing will also be discussed. The MicroObservatory is being developed with support from the National Science Foundation, Apple Computer, Inc. and the Kodak Corporation.

Revolutionary Classroom (W4-207B)

Experiencing the World Through the Use of Multimedia

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Key words: multimedia, accessing resources, bilingual, learner control

Abstract

The Los Angeles Learning Centers, one of nine sites funded by the New American Schools Development Corporation (NASDC), is a large urban school with predominately Latino students whose primary language is Spanish. Multimedia is assisting these students by creating a bridge for those who lack visual experiences, access to diverse resources, and tools for fully communicating their perspectives. We traditionally teach and test these students as though they have come to school prepared with common experiences. We are becoming increasingly aware, however, that these students are enrolling in school with very limited language acquisition experiences or exposure to events, facilities or natural settings outside the five mile radius from where they reside. For instance, there are implicit assumptions that they have been read to on a regular basis or taken to a museum, beach, forest or theme park. The use of media like videodisc, CD-ROM, and student and community produced video productions assists us in bringing some of those experiences to the students. Specifically, by creating thematic products with authoring tools and interactive media, our students are now active learners who manipulate and access information in a manner that stimulates development of the language acquisition and critical thinking skills necessary to continue acquiring and communicating new knowledge. These products are bilingual (English and Spanish) and will be presented by the teachers in this session.

Usng A Creation Station Platform

The Los Angeles Learning Centers have coined the term "creation station" to identify the technologies from which teachers, students, parents and others can access the type of learner controlled multimedia environment described. The number and types of "creation stations" are based on: (i) the level of creativity and learner control to be supported, (ii) the requisite degree of portability, and (iii) the nature of the training necessary to effectively use the technologies. The ideal is to ensure a mix of portable and stationary "creation stations" with several functional capabilities. The framework for examining these functional capabilities is as follows:

Find, access, exchange, and integrate a variety of audio, video, and data formulas

a. Utilizing electronic media (software, CD-ROM, etc.) contained either as part of the creation station or attached to it (videodisc players, etc.).

b. Receiving and transmitting audio, video and data on-demand from an intra-campus network.

c. Receiving and transmitting audio, video and data over telephone, satellite, cable and other communications/telecommunications systems.

Capture and Input

a. A variety of data types such as:

  1. Text
  2. Graphics, either created on a creation station or imported from scanning devices, digitizers, etc.
  3. Photographs imported from scanning devices, digitizers, photo-CD, etc.
  4. Analog NTSC video from any source.
  5. Stereo sound from live microphones and prerecorded resources.

b. Utilizing such devices as:

  1. Mouse, trackball, graphics tablet, and touch screen.
  2. Voice recognition/interaction.
  3. Handwriting recognition (pen-based technology).
  4. Keyboard, including ability to daisy chain keyboards to promote collaborative writing.

Store data on a local creation station or remote network server providing

a. Storage media sufficiently capable to be used for all appropriate tasks (including sufficient capacity, transfer rates and access speed).

b. Hard disk drive installed in the selected creation station suitable for selected tasks of the designated creation station.

c. Floppy disk drive installed in the selected creation station capable of reading and writing across multiple platforms.

d. Built in capability to increase disk storage capacity by utilizing additional hard disk drives, optical disk drives, removable media, etc.

Process, organize, and manipulate data on a system that has

a. Sufficient random access memory (RAM) to access and manipulate all forms of input.

b. Sufficient capability to expand main RAM and video RAM to be able to accommodate present and future needs.

c. Appropriate throughput capability (inclusive of clock speed, bus speed, input-output, transfer rates, compression/decompression algorithms, etc.).

d. Operating system capable of cutting and pasting audio, video and data within and between applications.

e. Hardware capable of responding to the continuous challenge of additional new functions. This can be accommodated by having capacity already built into the creation station or by adding cards into available slots when identified as necessary by the teaching/learning team.

Communicate and Output information by

a. Publishing products developed in electronic, paper and video formats.

b. Distributing products developed via intra-campus network or telecommunications.

c. Displaying a video output using a minimum of 256 colors.

d. Playing stereo sound.

e. Displaying an NTSC output to video monitor, projection system, video cassette recorder, etc.

Within this context, school staff can craft the choices best suited for their current and future instructional environment.

Special Session (W4-308A)

The Mad Netter's Tea Party

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Key words: networking, primary, secondary, mentoring, cooperative learning

Abstract

As networking grows in primary and secondary education, educators and researchers are realizing there is more than information on the network. There are people—people offering educational tea parties—on many different subjects. Education can begin to realize the untapped potential of mentoring, collaboration, and cooperative learning. When combined with the opportunity to give back to the world their learning, students become creators of knowledge, not merely vessels of antique essences.

Society Session (W4-310A)

Telecommunications and Teacher Education: Developing Electronic Communities of Teachers and Learners (ISTE SIGTE)

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Abstract

The advent of Internet connectivity has made it possible for individuals to communicate almost instantly with other individuals who are great distances apart. This capacity enables Teacher Education programs to offer a variety of experiences for their students which have never been possible before. What is it like to teach in an urban setting, a rural setting a school with a homogenous population or one with a highly heterogeneous population? Until now, most programs could offer its students an in-depth experience in only one of these settings, typically the one which is geographically co-located with the college or university. Through electronic networks, it becomes possible for students to vicariously experience these other settings in order to learn more about the complexity and thematic variations which exist across multi-national and multicultural school settings and instructional environments.

The Internet provides connectivity to millions of talented teachers enabling them to form an international electronic community of teachers and learners in pursuit of academic excellence. This powerful instructional medium provides Teacher Education programs with unprecedented opportunities for influencing the professional development of tomorrow's teachers.

This session will discuss the characteristics of several projects in which pre-service teachers from multiple institutions have become involved in instructional activities mediated via the Internet. Success stories, as well as problems and solutions, will be discussed. Panelists will discuss the details of their projects and programs and offer suggestions for others interested in developing similar programs.

The following topics will be addressed during the session:

Teaching Teleapprenticeships: A Model for Infusing Telecommunications Use in Pre-service Teacher Education at the University of Illinois in Urbana-Champaign

Michael Waugh, University of Illinois at Urbana-Champaign

Building Electronic Communities in Teacher Education at Mississippi State University

Larry Anderson, Mississippi State University

Applications of Telecommunications Technologies in the School of Education at Eastern Montana College

Barbara Brehm, Eastern Montana College

Using Electronic Networks for Instruction in the Baker Demonstration School of the College of Education at National-Louis University

Bonnie Thurber, National-Louis University

Using Electronic Networks to Enhance Pre-service Teacher Education in the College of Education at the University of Wisconsin-Eau Claire

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Project (W4-311A)

Pre-service Experiences and Teacher Computer Use

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Key words: research, instructional technology, pre-service teachers, in-service teachers

Abstract

This project presentation will discuss the results of a 1992/93 study investigating teacher pre-service experiences dealing with computer-related technologies and classroom computer use of recent graduates of Iowa State University. The study had three main purposes. The first was to investigate computer use and attitudes toward computers of new teachers. The second purpose was to obtain recent college graduates' opinions on their teacher pre-service preparation to use computer-related technologies. The third purpose was to investigate possible relationships between teacher pre-service experiences and teacher computer use.

One-hundred thirty-five teachers responded to the survey, "Survey of K-12 Computer-Related Technology Use by Iowa State Graduates". Results indicated these teachers were interested in using computer-related technology, but they actually used computers infrequently. They were much less proficient in using the newer, emerging technologies, such as video disks, hypermedia, and telecommunication, as compared to computer-based instruction and tool applications. Their general attitude toward computer-related technology was positive, and their attitude toward the importance of computers in education was very positive.

A high percentage of respondents indicated their teacher pre-service preparation for using computers in their classrooms was inadequate. Also, most indicated a computer-specific course was very important to teacher education, and many believed that computer-related technologies should be modeled by college instructors in all education courses.

When using all responses, there was low correlation between pre-service experiences and teacher computer use or teacher attitude toward computers. But, when using only the teachers' responses who had graduated after 1988, there was a correlation between taking an introductory pre-service computer-specific course and the following teacher variables: computer proficiency in using computers, interest in using computers, frequency of computer use, and computer use profile.

Based on the responses from this study, two recommendations for teacher pre-service institutions will be included in this presentation. Both deal with the preparation of future teachers to use computer-related technologies in their classrooms. The first recommendation will be the inclusion of a computer-specific introductory course in teacher pre-service programs. This type of course should have two main themes, 1) strategies for integrating computers into all disciplines, and 2) personal computing proficiency. These course goals follow the ISTE/NCATE standards for computer education for pre-service teachers.

The other recommendation for teacher pre-service deals with the necessity of modeling by all education instructors. Students must experience learning with technology, not just be told about it.

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